THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

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ASSISTED BY A LARGE STAFF OF COLLABORATORS

FULLY ILLUSTRATED

Volume V — Conjunctivitis Phlyctenulosa Pustulosa to Dioptrics

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INTRODUCTION

In renewing his thanks to those collaborators who have given him such valuable assistance in the preparation of the first five volumes of this *Encyclopedia,* the Editor desires also to repeat an expression of his indebtedness to the literary and other sources of information mentioned in the Introduction to Vol. I.

Dr. Shastid has requested permission to acknowledge once more his great obligations to the works of Professor Julius Hirschberg, whom he regards as almost the creator of ophthalmologic history and biography. Further, though in less degree, is he debtor to various general histories of medicine, especially those of Baas, Haeser and Neuburger; Atkinson's "*Physicians and Surgeons of the U. S.;*" Ball's "*Andreas Vesalius;*" Bock's "*Die Brille und Ihre Geschichte;*" Caesemaeker's "*Notice sur les Lunettes et Verres Optiques;*" Carpentier's "*Nos Ancêtres;*" Castillo's "*Augenheilkunde in der Römerzeit;*" Caton's "*Temples and Ritual of Asklepios*" and "*I-em-hotep and Ancient Egyptian Medicine;*" Creighton's "*History of Epidemics in Britain;*" Frank's "*Caricature in Medicine*" and "*Biographical Sketch of Some Representative Ophthalmic Surgeons*" (in Wood's "*System of Ophthalmic Operations*"); Géržetime's "*Ueber Medecin und Sonnencultus des Alterthums;*" Goethe's "*Farbenlehre*" and "*Dichtung und Wahrheit;*" Hirsch's "*Geschichte der Augenheilkunde;*" Hirsch and Gurlt's "*Biographisches Lexikon der Aertze;*" Hubbell's "*Ophthalmology in America;*" Kelly's "*Cyclopedia of American Medical Biography*" and "*Some American Medical Botanists;*" Klein's "*Stempel Römischer Augenärtze;*" Magnus's "*Anatomie des Auges in Ihrer Geschicht. Entwickelung,*" "*Augenheilkunde der Alten,*" and "*Geschichte des Grauen Staares;*" Mollet's "*La Médécine chez les Grecs avant Hippocrate;*" Mumford's "*Medicine in America;*" Nutting and Dock's "*A History of Nursing;*" Packard's "*History of Medicine in the U. S.;*" Pagel's "*Biographisches Lexikon;* Pansier's "*Histoire des Lunettes,*" "*Histoire de l'Ophtalmologie*" (with True), "*Histoire de l'Ophtalmologie à l'Ecole de Montpellier;*" Puschmann's "*History of Medical Education;*" Rosenberger's "*Geschichte der Physik;*" Stone's "*Biography of Eminent American Physicians and Surgeons;*" Terson's "*Etudes sur l'Histoire de la*

Chirurgie Oculaire;" "*Universities and Their Sons;*" Walsh's "*Old Time Makers of Medicine,*" and "*Education, How Old the New;*" Wiedemann's "*Ueber die Naturwissenschaften bei den Arabern;*" Wooton's "*Chronicles of Pharmacy;*" also, to numerous obituaries in various ophthalmological journals. He also desires to acknowledge his indebtedness to hundreds of correspondents in various portions of the world for biographical and historical information for use in this *Encyclopedia.*

The Editor wishes to add to the foregoing statement of Dr. Shastid that, wherever possible and desirable, the Doctor has consulted the original works of the ophthalmologists whose lives he has written for this *Encyclopedia.* The list above-presented is merely that of Dr. Shastid's secondary authorities—those to which he feels himself indebted in a special sense.

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LIST OF LEADING SUBJECTS IN THIS VOLUME

Conjunctivitis, Phlyctenular. PHLYCTENULAR OPHTHALMIA. SCROFULOUS OR STRUMOUS OPHTHALMIA. ECZEMATOUS CONJUNCTIVITIS. LYMPHATIC OPHTHALMIA OR CONJUNCTIVITIS. This is one of quite a distinct class of conjunctivitides which are to be regarded as expressions of dyscrasiæ, depending not so much upon the introduction of pathological germs from without, as the causative factor, but rather upon the condition of the general system and the state of the nutrition as the most important factors.

The dyscrasia known as scrofula or struma manifests itself in the conjunctiva more frequently than any other disease of malnutrition, and is especially frequent in children, though adults are by no means free from it. The appearance of vesicles on the conjunctiva is not of course a certain indication of established scrofula, as they often occur during a temporary lowering of the nutritive powers in children who are apparently strong and show no evidence of the dyscrasia elsewhere, and there are cases of pronounced and severe forms of strumous disease in which the conjunctiva is slightly or not at all affected. Still, the appearance of these vesicles on the conjunctiva can be accepted as a certain sign of faulty assimilation, and generally of the impoverished condition of the blood.

It would seem probable too, that in some instances at least, the vesicles are manifestations of a derangement at the nerve-centers analogous to, if not identical with, that causing herpes zoster. We can hardly account otherwise for the very pronounced nervous symptoms, such as severe pain, lachrymation, and photophobia, which we not uncommonly see. There is no other disease which varies so widely in the intensity of its symptoms; and what is still more remarkable, the subjective symptoms do not seem to bear any direct relation to the objective manifestations. Frequently a minute vesicle, especially if situated on the cornea or corneo-scleral margin, will be associated with the most intense pain, photophobia, and lachrymation persisting for days and weeks, while two or three large ones scattered over the conjunctiva give rise to comparatively little inconvenience. This is due both to the extreme susceptibility of the nervous system, and the pressure made directly on the filament of a nerve by the exudation. This latter is more apt to be the case where the vesicle is situated on the conjunctival layer of the cornea, where the nervous supply of the fifth pair is more generous and the arrangement of the terminal filaments among the epithelial layers is such as to lead more readily to such pressure. In the same way we may account for differences in the severity of various attacks in the same person, one being mild, and another, with the same objective appearances, very severe.

The location of the exudate may be on the conjunctiva proper, or in the epithelial layer of the cornea which is continuous and anatomically identical with that of the conjunctiva and sclera. The exudate lies between the epithelium and the layer of Bowman. It is not, as a rule, fluid, but consists of an aggregation of round lymphoid cells. The epithelium at the apex soon separates, the underlying tissue becomes softened and breaks down, and thus a minute gray ulcer is produced. New epithelium soon forms over the ulcer, however, and after healing no scar remains. The characteristic pathological change is what appears to be a vesicle varying in size, from that of a pin-head or less, to a bleb three or four millimetres in diameter and approaching that of a bulla. The associated conjunctival vascularization may be only a bunch of fine vessels running from the equator of the ball forward to unite at the base of the phlyctenula, the remainder of the conjunctiva being perfectly clear, or it may be general and diffuse, approaching that of a muco-purulent conjunctivitis. Though usually single, there may be any number of these phlyctenulæ, and sometimes they form a circlet around the base of the cornea. There is frequently associated with the conjunctival disease a swollen condition of the edges of the lids, and sometimes of the whole lid. The discharge may be either watery or muco-purulent. The discharge is very acrid in some cases and causes an eczema of the cheeks, lips, and the inside of the nose. In badly nourished and ill-cared-for children the whole face is sometimes covered with scabs and excoriations as a result of this irritation. When there is persistent blepharospasm as a result of the intense photophobia there will frequently be seen excoriation and ulceration in the folds of the skin at the outer canthus. There may be even a total eversion of the lids (ectopia conjunctivæ) when the blepharospasm is very intense and obstinate. Actual pain, aside from the photophobia is not usually great, but the photophobia is usually extreme in children; the patient hides in a dark corner or buries his head in the pillow, making an examination very difficult. The child often presents a characteristic strumous appearance, being pale and thin, or flabby. Enlarged cervical lymphatic glands, adenoid vegetations in the pharynx, thick lips, eczema of the nose and upper lid, and purulent otitis media are often seen in these children. Although the disease has long been regarded as being of strumous origin, it has always been difficult to trace any definite tubercular association. There is a definite lesion, tubercle of the conjunctiva, infrequent certainly in comparison with phlyctenular conjunctivitis, but well characterized, and easily differentiated from it, showing the presence of the tubercle bacillus. Phlyctenules on the other hand do

not show the presence of tubucle bacilli; at least their presence has never been demonstrated. In cases of phlyctenular ulcer, the opsonic index is usually very low. This is probably because it is the toxin which has the power of setting up phlyctenules, whereas in tubercle of the conjunctiva, the bacilli are present. An interesting study of the opsonic index for tubercle in phlyctenular conjunctivitis was made by Nias and Paton (*Trans. Ophth. Soc. United King.*, March, 1916).

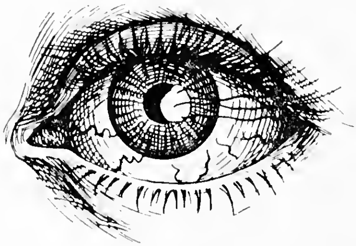
Phlyctenular conjunctivitis is not contagious. When a phlyctenular ulcer advances from the periphery towards the centre of the cornea, it is followed by a narrow band of vessels. The name *fascicular keratitis* has been given to this condition. The life period of each phlyctenula is from a few days to several weeks.

Phlyctenular conjunctivitis must be distinguished from herpes of the conjunctiva, with which it is liable to be confounded. In the latter condition the vesicles are transparent, appear in clusters, and do not show a predilection for the limbus. In spring catarrh the elevations are larger and do not ulcerate. Trachoma of the bulbar conjunctiva is associated with the same process in the conjunctiva of the lids and rarely involves the limbus. Acne rosacea of the conjunctiva closely resembles phlyctenular conjunctivitis, but the diagnosis can be made from the fact that the former disease occurs only in adults who at the same time present acne rosacea. For the bacteriology of phlyctenular conjunctivitis, the reader is referred to page 832, Vol. II of this *Encyclopedia*.

In the treatment of phlyctenular conjunctivitis, it must be remembered that as the disease is largely the local expression of a systemic condition, it is the surgeon's duty to find the cause and remove it, while at the same time local treatment is employed. Only the most nutritious articles of food should be allowed, such as milk, eggs, beef, mutton, and fowl. No pork or veal, very little bread or potatoes, and no sugar or fat. Tea and coffee only in moderation. A child with phlyctenular conjunctivitis should not be kept in-doors nor in a darkened room, even though the photophobia is great. On the contrary he should be compelled to obtain fresh air and sunlight, and the eyes should be protected with colored glasses. The skin should be kept clean and the bowels open. In regard to drugs, iron in some form has been most generally employed. For a child perhaps the best preparation is the syrup of the iodid of iron, in doses of from fifteen to thirty drops, given three times a day, in water. In those cases which do not respond to this general treatment, the salicylate of soda in large doses (three grains every four hours, for a child of five years). The effects must be carefully watched, depression and tinnitus being signals

for the temporary interruption of the doses. This treatment should be discontinued if improvement does not follow in a few days (Gradle).

For the local treatment atropin is indicated where there is much irritation, cocain or holocain can be used occasionally. If, as is often the case, the vesicles have already burst, at the time of the first examination, the local use of mercury is indicated. Finely powdered calomel dusted onto the ulcers, or the ointment of yellow oxide of mercury, one grain to the dram, are probably the best preparations. Calomel should not be used if the patient is taking iodid of potassium internally, since the potassium iodid in the tears, uniting with the calomel, will form double iodids and cause irritation. The treatment with the yellow oxide should be continued for a week or more after



Fascicular Keratitis.

all signs of the local inflammation have disappeared. Concomitant lesions of the nose, skin, ear, pharynx, and lymphatic glands should receive proper attention, and finally the patient's refraction should be examined, and any existing ametropia corrected.

Hicks (*Ophthalmic Record*, May, 1911), maintains that the pathology of this condition is that it is a localized inflammation due to one of the common pyogenic organisms.

In obstinate cases he advises excision of the phlyctenule freely, getting well beyond the margin to be out of the zone of infection. Adrenalin should not be used as the limits may thereby be masked. The edges of the conjunctiva are sutured.

In multiple phlyctenulæ he does not advise this treatment. These cases, he says, get well rapidly under ordinary treatment. He does not mention tubercle as a causal agent which is now so largely held, nor of the good results of tuberculin treatment.—(C. P. S.)

Conjunctivitis phlyctenulosa pustulosa. (L.) Malignant phlyctenular conjunctivitis.

Conjunctivitis phlyctenulosa simplex. (L.) A form of conjunctivitis characterized by the presence of several small vesicles on or near the

corneal margin, generally below the horizontal diameter. The swelling and infiltration of the conjunctiva is moderate; but there are usually considerable lachrymation and photophobia, and some little mucous secretion. See **Conjunctivitis, Phlyctenular.**

Conjunctivitis, Plastic. See **Conjunctivitis, Membranous.**

Conjunctivitis pseudomembranacea. (L.) PSEUDO-MEMBRANOUS CONJUNCTIVITIS. See **Conjunctivitis, Membranous.**

Conjunctivitis, Pseudo-membranous. See **Conjunctivitis, Membranous.**

Conjunctivitis, Public-bath. See **Conjunctivitis, Swimming-pool.**

Conjunctivitis puro-mucosa catarrhalis. (L.) CATARRHAL CONJUNCTIVITIS. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis puro-mucosa contagiosa (seu **ægyptiaca**). (L.) CONJUNCTIVITIS PURULENTA. Purulent conjunctivitis. See **Conjunctivitis, Purulent.**

Conjunctivitis, Purulent. PURULENT OR GONORRHEAL OPHTHALMIA. OPHTHALMIA NEONATORUM. OPHTHALMOBLENNORRHEA NEONATORUM. This is essentially an infectious disease caused in a large majority of cases by the diplococcus of Neisser. A very large part of the blindness throughout the world, from one-third to one-half of the total amount according to different estimates, is due to the ravages of this disease. It occurs either in infants within two or three days after birth, when it is known as ophthalmia neonatorum, or in adults where it is called gonorrheal ophthalmia. It has been supposed that ordinarily ophthalmia neonatorum is caused by the gonococcus in practically all cases, but recent investigations have shown that purulent inflammations of the conjunctiva are caused by various micro-organisms. Stephenson and others, in 1895, found the staphylococcus pyogenes aureus and albus, the streptococcus pyogenes, and the pneumococcus, in the muco-purulent discharge in this disease.

Groenouw has recently found the bacillus coli communis, associated with other micro-organisms in six out of forty cases of ophthalmia neonatorum. A case of blennorrhea in a new-born child has been reported by Bietti in which only the colon bacillus was found. In cases of localized diphtheritic conjunctivitis with abundant purulent secretion, the cornea may undergo rapidly extending necrosis due to infection of the Klebs-Loeffler bacillus. In view of these facts, the medicolegal importance of these observations should not be overlooked, and the surgeon is not justified in making positive statements as to the etiology of a case of purulent ophthalmia without having made a careful bacteriologic examination. After an extensive study of this subject Druais asserts that instead of finding that practically all cases of ophthalmia neonatorum are due to vaginal infection and

nearly always gonococcic, he asserts that on the contrary not more than half of the conjunctivitis of the new born is of gonococcic origin. Cases of purulent ophthalmia in the new born occur in spite of the most thorough vaginal disinfection by the most careful accoucheurs. The conjunctivitis, too, may occur before the infant is born. Children have been born with the cornea perforated or even with the ball emptied by corneal sloughing from intrauterine conjunctivitis. This fact is well illustrated by the case of a child delivered by Cesarean section, reported by Druais. As soon as its head appeared in the uterine incision those present noticed that its eyes were red, swollen, and full of secretion. Microscopic examination of the pus showed both diplococci and staphylococci.

The histology of gonorrheal conjunctivitis has been carefully studied by Waldstein of Prague (von Graefe's *Archiv. für Ophthalmolgie,* 72, 2), who, for this investigation removed small pieces of tissue from the transitional fold and tarsal portion of the conjunctiva in cases of gonorrheal conjunctivitis. They represented all stages of the disease from 2 to 60 days after the outbreak of the inflammation in babies, children, and adults. He examined 19 pieces of tissue obtained from 16 separate cases. Of these 8 were cases of ophthalmia neonatorum in which the gonococcus was present and 2 more cases believed to be gonorrheal in origin although the micro-organism was not found. In addition to these there were four cases of acute conjunctivitis due to the micrococcus catarrhalis. He gives a minute account of the histological findings in all these cases.

In considering the cases of ophthalmia neonatorum he divides them into three groups: 1. Up to about 14 days, when the destructive process predominates. 2. From 2 to 4 weeks, when tissues gain the upper hand over the invading germs. 3. The stage of repair and return to normal condition.

The more important facts concerning these groups are as follows: Group 1 (cases 1—4). In this there was vascular dilatation and infiltration of the connective tissue stroma and epithelium by phagocytes. The epithelium presented signs of severe damage, becoming necrosed, and shed into the secretion. Some attempt at repair could be seen during the latter half of the first week. There was an ingrowth of the epithelium into the sub-epithelial tissues. These downgrowths had the appearance on section of glands, and some of the epithelial cells had become goblet cells. The phagocytes consisted almost entirely of polynuclear neutrophile leucocytes which came from the neighboring blood-vessels. The gonococci in the superficial cells caused necrosis and the cells became detached. The gonococci

then attacked the deeper layers extending even beyond the basal layer into the sub-epithelial tissue. The secretion corresponded to these changes, being sero-saneous with few cells in the early stages and becoming later thick and creamy and containing more cells. Besides the epithelial cells there were polynuclear neutrophile leucocytes, 95 per cent. or more with a few lymphocytes. The cells contained gonococci.

Group 2 (cases 5—7). The round cell filtration was subsiding and the epithelium was less defective. The increased vascularity was diminishing. The gonococci were less in number and mostly intracellular in superficial layers. In the secretion the number of lymphocytes seemed greater than the leucocytes and the gonococci less in number. The epithelial cells were disappearing from the secretion.

Group 3 (cases 8—9). The epithelium was regenerated but the arrangement was not normal. Besides poly- and mono-nuclear leucocytes this stage was characterized by the presence of a number of mast cells which wandering through the epithelium escaped with the other cells in the secretion. These cells underwent considerable change in appearance as they passed to the surface from the deeper layers. As these cells have not been observed in the secretion Waldstein thinks they undergo degeneration and a granular detritus is all that remains. Gonococci were entirely absent in this stage.

The two cases of ophthalmia neonatorum where no gonococci could be found, except for this, differed in no respect histologically from the gonorrheal cases.

The cases of gonorrheal conjunctivitis in adults (cases 12—17) were in all phases entirely similar histologically to those cases described above. Lastly, the two cases due to the micrococcus catarrhalis are considered. In all important features they agreed with the gonorrheal cases. The bacteria, however, were not present in the attached epithelium. They enter the cells but are quickly eliminated by the epithelium being cast off owing to necrosis taking place. Of course the micrococci are present in the secretion. Waldstein believes that the difference between the two conditions is due to the different actions of the two toxins they produce. A point also to be considered may be the fact that the gonococcus enters the epithelial cells more easily than the micrococcus catarrhalis.

In conclusion he sums up the results of his investigations as follows: (1) Gonorrheal conjunctivitis is an inflammation which confines itself to the superficial layers of the conjunctiva. (2) The gonococci, for the most part, occupy the upper and middle portions of the epithelium but when this is shed reach the basal layer and pass

into the sub-epithelial tissue. They are nearly always intra-cellular. (3) Repair begins in the second half of the first week. Active growth takes place into the depth of the necrotic tissue giving rise to gland-like structures containing goblet cells. (4) The sub-epithelial infiltration consists in the main of plasma cells—in which mitosis is a frequent occurrence. Mast cells, which increase in number later, pass through the epithelium to the surface and so into the secretion. (5) Eosinophile cells play no essential part in gonorrheal conjunctivitis. (6) A great increase in the blood-vessels takes place from which emigrate the polynuclear neutrophile leucocytes, plasma, and mast cells. (7) The connective tissue only plays a small part in the inflammation and the elastic fibres undergo no alteration. (8) The gonorrheal conjunctivitis of the adult differs histologically in no respect from that in the newborn. (9) The ophthalmia neonatorum, in which no bacteria are present, differs only from the gonorrheal by the absence of the gonococcus. (10) The blennorrhea due to the micrococcus catarrhalis, in contrast to the gonorrheal, shows less damage to the epithelium even in the earliest days. The organism is confined to the superficial layers and easily eliminated.

The subject of purulent ophthalmia therefore may be classified under three heads: (1) gonorrheal ophthalmia of the adult; (2) gonorrheal ophthalmia of the newborn; (3) purulent ophthalmia not due to the gonococcus (Ball).

Gonorrheal ophthalmia of the adult.—This is always a serious disease, due to the inoculation of the conjunctiva with the gonococcus of Neisser. The poison is usually conveyed by the fingers, handkerchief, towel or wash-bowl that has been contaminated with pus from a vaginal or urethral discharge. It is improbable that the germ is carried by the air. It is more frequent in men than in women. Considering the contagiousness of the gonococcus it is remarkable that the proportion of persons suffering from gonorrhea who have gonorrheal ophthalmia is so small. This is doubtless due chiefly to the protection which the lids and tears afford, but it is possibly also due in part to a low degree of immunity conferred by the disease (Parsons). It has been demonstrated by Haltenhoff that endogenous gonorrheal conjunctivitis occurs. Gonococci are carried in the blood-stream to the eyes and there set up an inflammation, just as in the joints. As in this latter situation, so in the eyes, gonococci themselves are generally absent; they are probably present in the tissues, but not in the secretions. In these metastatic gonorrheal affections the conjunctivitis often recurs, not necessarily simultaneously with the

joint affection (Gielen). Metastasis from a primary gonorrheal conjunctivitis is much rarer, but cases have been proved.

Gonorrheal ophthalmia of the adult is usually characterized by an abundant secretion of pus, and great swelling of the lids; there is also a marked constitutional disturbance. The tendency to corneal involvement must be kept in mind.

The incubation period ranges from a few hours to three days. The next stage, that of infiltration, lasts for two or three days, during which period the symptoms of an acute catarrhal conjunctivitis develop. The lids soon become swollen and hard, the upper lid especially often becoming enormously enlarged and eversion of the lids is impossible. Minute hemorrhagic spots are often seen in the swollen conjunctival surfaces of the lids. The conjunctiva has a deep red velvety appearance, and is hard, rough and granular. Chemosis of the ocular conjunctiva usually develops, and the swelling may be so great that the membrane will protrude between the lids. There is severe pain in and around the eye. The pre-auricular glands are tender and swollen and may suppurate. There is a local and general rise of temperature and often a general systemic depression. In the next stage, when the nature of the discharge changes from a watery to a purulent character, the lids become less hard and tender, and the inflammatory symptoms less marked. The yellow or yellowish-green pus oozes out of the conjunctival sac in profuse quantities, and this continues for two or three weeks until the next stage, that of convalescence, sets in. The entire course of the disease lasts six or eight weeks. The conjunctiva may return to its normal condition, or a condition of chronic blennorrhea may supervene in which there is general redness of the membrane, with some thickening and the presence of enlarged papillæ.

The clinical symptoms vary according to the intensity of the infection. As a rule, the mildest cases are those due to gleet; the severest result from infection with pus from a violent gonorrhea. In severe cases a croupous deposit may form on the conjunctival surface, and even a deep infiltration similar to that seen in diphtheritic conjunctivitis, occurs in the severest cases. Among the numerous complications and sequels of this disease, the most dreaded is corneal involvement, especially ulcers which result either from infection or as a result of the prolonged and severe pressure upon the blood-vessels. These ulcers may heal or go on to perforation. Perforation of a central ulcer, by allowing the aqueous to escape permits the lens to come forward to the opening which becomes sealed by a deposit of lymph. The aqueous then reforming, is followed by reposition of the lens which carries with it a tag of lymph, thus forming an

anterior polar cataract. Anterior synechia and *adherent leucoma* may also result. Infection of the ciliary body and choroid through a perforating ulcer usually results in complete destruction of the eye by *panophthalmitis,* or in the slow shrinking of the globe which characterizes *phthisis bulbi.* The cornea may be so weakened by the inflammatory process, that the intra-ocular pressure acting on the weakened structure may produce a *staphyloma.*

The prognosis of gonorrheal ophthalmia is more favorable in the young than in elderly persons. It depends on the intensity of the inflammation, and on the intelligent treatment of existing conditions in each individual case. Intense chemosis increases the danger. Central ulcers are much more serious than marginal ones. The appearance of the cornea in the early stages is a good guide to probable later development. If it is cloudy the outlook is unfavorable; if milky, the cornea will almost surely slough. Sudden pain occurring in the course of a gonorrheal ophthalmia usually means either the perforation of the cornea or a beginning iritis. Even if the eyeball is not destroyed, the vision is often very much reduced from the scarring of the cornea.

Treatment. In the earliest stages of the disease cold applications are useful. Pieces of gauze or linen two inches square and several layers in thickness placed on a cake of ice should be applied at two minute intervals; the piece removed should be destroyed. This process should be kept up both night and day if the case is a severe one. The general condition of the patient should be watched, the bowels kept open and the pulse kept down. If pain is severe one of the preparations of opium should be used. Where the lids are greatly swollen a canthotomy may be done, under general anesthesia. With a pair of strong scissors the tissues at the external canthus are cut down to the bone. The hard chemotic conjunctiva can then be seen and scarified in a radiating direction from the cornea. Engorgement of the blood-vessels and pressure on the eye is thus removed. The conjunctival sac can then be irrigated with warm boric acid solution (1 per cent.) or bichlorid solution (1 to 4,000).

In the next stage, when there is the profuse purulent discharge, the important thing to be considered in treating the case is to keep the conjunctiva as clean as possible. The cold applications can now be discontinued, and the aim of the surgeon is to keep the conjunctival sac free from the accumulation of pus. There should be both a day and a night nurse, as it is of the greatest importance that the eye be cleansed as frequently as every half hour, while the purulent discharge is excessive. The cleansing may be done by various methods:

mopping up the pus with absorbent cotton and washing the cul-de-sac with boric acid solution by means of a pipette, or keeping the surfaces clean by a continuous stream, as advocated by some.

Hosford and James (*Lancet*, Jan. 13, 1912) point out the disastrous results which so often attend gonorrheal conjunctivitis in the adult after the age of 30, and that involvement of the cornea constitutes the great danger. This complication may be the result of (1) sloughing from strangulation, (2) abrasion of the epithelium by even gentle manipulation, (3) injury to the vitality of the corneal structures from the digestive powers of the toxic products contained in the discharge, and finally (4) the pernicious influence of caustics and astringents (silver nitrate, protargol, argyrol and perchloride of mercury) applied in the early stages of the disease. It is believed that these remedies lead to greater constriction and chemosis, while they merely remove the superficial layers, leaving the deeper structures of the conjunctiva untouched; that such applications are distressing and exhausting to the patient; that they are attended with positive danger to the cornea; and that this method of treatment is, even in favorable cases, a lengthy one and leaves the conjunctiva irritable and occasionally papillomatous for many weeks with the risk of recurring ulceration of the cornea.

For some years Hosford and James have adopted the following plan of treatment with uniformly gratifying success commencing at the earliest possible moment: The patient is kept in bed and on a low diet, the bowels kept open, and aspirin and quinine given internally. Locally the constant use of the douche is regarded as the primary curative factor. The solution found most satisfactory is potassium permanganate 1 to 15000 to 1 to 20000 in the early stages and boric acid, gr. viii to oz. i in the later stages, at a temperature of from 85° to 90°. No ointment is used as it tends to interfere with the proper application of the solution. The patient is encouraged to open his eyes slightly every ten minutes. No manipulation of the lids is permitted except by the surgeon.

In the arrangement of the douche the can should be placed not higher than one foot above the patient's head. The end of the fine rubber tube leading from it should be either fixed by plaster or held at the naso-orbital margin, and the stream allowed to trickle constantly across the palpebral fissure, which it will be found that there is a tendency for it to do if properly adjusted. If a slight coating forms along the lashes it can be removed readily by a warm solution of sodii bicarb., gr. x. to the ounce, the lashes being gently stroked downwards. For the first four days, provided that sequelæ do not

call for further examination, only the gentlest attempts should be made to expose and inspect the eye. After this time, as the swelling is in all probability subsiding, the cornea should be carefully examined for minute specks, and signs of iritis or hemorrhages into the interior chamber should be looked for. The patient should be encouraged to open the lids himself, the surgeon merely assisting by the gentlest manipulation of the upper lid. It will be observed in the severer cases that the chemosis in itself tends to keep the lids apart, or at least prevents firm closure, and that the portion thus exposed and submitted to the stream of fluid includes that part of the cornea—i. e., the lower limbus—most susceptible to damage from the toxic inflammatory products.

If the disease is diagnosed in the first days and irrigation is at once adopted a surprising improvement will be seen in the course of the next four days, and the surgeon may be tempted to relax the continuous douche. Relapse is, however, much to be feared if the treatment is not continued for the next three or four days. It may be pointed out also that even in the neglected cases, where the patient is seen by a specialist at a dangerously late stage, eight days continuous irrigation will be found sufficient to bring the case completely under control, provided the cornea is not affected when the surgeon is called in.

Even if corneal complications arise they advise a continuance of the irrigation and the avoidance of cautery or use of silver compounds; they have not seen any ulcers under this plan of treatment.

If an ulcer of the cornea develops, centrally situated, atropin (gr. iv to ʒ j) should be instilled three times daily, and the ulcer washed frequently with formalin (1 to 2000). This antiseptic solution, which is the aqueous solution of a gas, has the power of penetrating tissues, and is said to be of great value in the treatment of corneal ulceration. If the ulcer is marginal, eserin (1/10 to 1/5 of 1 per cent.) should be used in the attempt to prevent prolapse of the iris. Eserin must not be used, however, if iritis is present.

When but one eye is affected, the other should be immediately sealed up by means of a Buller's shield, and the patient should be warned of the danger of infecting the second eye.

If the surgeon should infect his own eye while examining a case of gonorrheal ophthalmia, he should wash out his conjunctiva with boric acid solution and have applied to the membrane a strong solution of nitrate of silver (gr. x — xxx to ʒ j). This treatment may abort the disease, but is applicable only to the period immediately following the infection.

Goldzieher (*Arch. d'Ophtalmologie,* Vol. 32, No. 3. p. 129, March, 1912), suggests a novel method of treating this much dreaded condition, which is well worth considering, in view of the success he has obtained with it. He starts with the two facts that the gonococcus lives on the surface and between the epithelial cells, rarely penetrating to the subepithelial cells; and that a temperature of 44° kills the gonococcus in ten minutes, a temperature of 45° instantly. Accordingly he has had an electric water boiler constructed, from which *steam can be projected on the eye.* Experiments showed that at a distance of four centimeters from the discharge tube the steam had a temperature of 45°, but, in order to be safe, he uses a distance of two to three centimeters. This apparatus cannot be used until the lids have lost their board hardness and can be turned, which is about the second day. This is no objection to the method, as the infiltration and destruction of the cornea do not begin until after this time. Cocain is of no value for deadening the pain. The conjunctival sac is first washed with a solution of potassium permanganate or a weak solution of oxycyanid of mercury. The cornea is protected by the upper lid; if the latter cannot be well everted the temperature of the steam should be a little higher, so as to penetrate through the lid to the conjunctiva of the fornix. The neighboring parts are protected with moist gauze. No mention is made of the length of time the eyes are exposed to the steam. Only the first application is painful.

Fifteen eyes were treated; in ten of these the cornea was intact at the time of admission, and all were quickly and permanently cured. The rapid regression of the acute symptoms, such as the swelling of the lids, the chemosis, and the purulent secretion was really remarkable, attaining its maximum often on the fourth day. The conjunctiva was again smooth, and the cornea intact in all cases where it was intact at the beginning of the treatment.

In the five cases where the cornea was already attacked it was not possible to save the structure as a transparent tissue, but still a great deal was accomplished by this mode of treatment as the following case illustrates: A man had been under routine treatment (silver nitrate, blenolenicet) for eighteen days. When first seen the cornea was entirely destroyed, the iris protruding through the corneal rim. Suppuration was profuse, the conjunctiva highly swollen, and the pain intense. The patient begged to be put in condition to resume his work. Under chloroform the eye was enucleated, and on the third day the vaporizations were begun. Three days later the suppuration had ceased entirely, and the patient soon returned to his work.

Although the conjunctiva is made aseptic, as far as the gonococcus

is concerned, it would be unreasonable to expect an entirely normal conjunctiva after five or six vaporizations. As a matter of fact, there still remains a marked hyperemia and some swelling of the conjunctiva, but these subside under irrigations with potassium permanganate, or, better yet, one-half per cent. sulphate of zinc. In the majority of the cases nitrate of silver was not used at any stage.

Goldzieher thinks the superiority of this new procedure over the silver nitrate treatment is due to the fact that the heat penetrates into the epithelial layers into which the silver nitrate blocks its own way by forming a precipitate.

Gonorrheal ophthalmia of the new-born. This acute inflammation of the conjunctiva, which is usually due to gonococcic infection, begins to show itself on the second or third day after birth. The symptoms

Ophthalmia Neonatorum.

are about the same as in gonorrheal conjunctivitis in the adult, except that the process is less severe and the corneal complications less frequent. There is first a redness of the eyelids and a muco-purulent discharge. Slight conjunctival hyperemia is soon succeeded by great swelling of the lids, chemosis and profuse purulent discharge (see figure). One eye is generally infected first, and if promptly and thoroughly treated the process is much less severe in the second eye. There is great swelling of the retrotarsal fold, so that sometimes the upper lid becomes spontaneously everted when the child cries, and the fornix appears as a red suppurating mass resembling granulations.

Inoculation by the gonococcus occurs either during the passing of the child through the maternal passages, or shortly after, and in a few cases at least *in utero,* since the disease was present at birth. When labor has been slow, and especially in face presentations, infection is much more common.

The diagnosis of ophthalmia neonatorum should present no difficulty. Any redness or discharge about the eyes of an infant occurring during the first week of life is to be regarded as of gonococcic origin unless a bacteriologic examination shows it to be otherwise.

While it is always a serious disease, if recognized in the very beginning and properly treated few eyes will be lost, although a small nebula often remains on the cornea. On the other hand if the case is not seen early, and improperly treated, fully 80 per cent. of the eyes affected will end in blindness, due to sloughing of the cornea.

Credé-Hoerder (*Deutsch. med. Wochenschr.*, Jan. 9, 1913, p. 74) thinks that a microscopic examination in many cases would show that the diagnosis of gonorrheic ophthalmo-blennorrhea is made too frequently. The non-gonorrheic form presents the following aspect: Agglutination of lids, redness of the lid borders and their surroundings, moderate edematous swelling of the upper lid, purulent or seropurulent secretion, redness of conjunctiva, thin deposits on the palpebral conjunctiva, cornea clear. Its course differs very much from the gonorrheic form by the intactness of the cornea and the scanty, more serous, secretion. Microscopically the writer found Fraenkel's pneumococci and *B.* coli. The treatment in his cases consisted in irrigation with boric acid solution and, in a severe case of pneumococci blennorrhea which commenced on the eighth day after birth, in instillations of acetate of silver 1.3 per cent. on the first and fifth days of the disease. He considers the careful treatment of the otherwise harmless non-gonorrheic ophthalmo-blennorrhea of great importance for preventing later chronic conjunctivitis, which may be very difficult to cure.

Quite early after Neisser's discovery of the gonococcus it was recognized that in many cases of ophthalmia neonatorum this organism was not to be found. And it was observed that these cases, though often beginning acutely, commonly took a comparatively mild course, with little danger to the cornea. The incubation period of these cases was found to be somewhat longer than that of the gonococcal cases. In a varying proportion of them organisms such as pneumococcus, staphylococcus aureus, etc., were found and held to be causative. But still a considerable proportion of the attacks were left unexplained.

The recent findings in ophthalmia neonatorum by a number of investigators from 1908 onwards, of cell-inclusions morphologically indistinguishable from Halberstädter and v. Prowazek's trachoma bodies (chlamydozoa), have been of great interest. The bodies have been found not only in the infant's conjunctiva, but also in the mother's vagina and in the male urethra in certain cases of urethritis. Though at times associated with the gonococcus, the bodies have been found mostly alone or merely with indifferent bacteria. For the present the cases of ophthalmia neonatorum thus distinguished are

known as "inclusion" blennorrhea. But observations are fast accumulating to prove that "inclusion" ophthalmia is true infantile trachoma.

Without laying much weight upon the relative immunity shown by infants towards general systemic affections, attention is drawn to the relatively good prognosis of gonorrheal conjunctivitis and of trachoma in early life as compared with adult life. The earlier the age, the better the prognosis in both affections. Gonococcal conjunctivitis is held to be less serious in the new-born than in infants a year old.

Putting aside unconfirmed findings of chlamydozoa in the normal conjunctiva, Lindner maintains (v. Graefe's *Archiv. f. Ophthal.*, lxxviii) that the bodies have been found in adults' and in children's eyes only in trachoma, and in infants' only in "inclusion" ophthalmia. Therefore, unless these two affections be etiologically identical, we must take the entirely unacceptable view that although the otherwise particularly resistant infantile conjunctiva and the adult genital membrane are both vulnerable to the "inclusion" virus, yet the ordinarily more vulnerable adult conjunctiva is immune to this infection. We must surely expect on the other hand to find the adult conjunctiva more severely invaded than the infantile.

A certain amount of confusion has arisen, both as regards clinical and bacteriological observations, from mixed infections in adults of gonorrheal conjunctivitis and trachoma. These mixed infections, beginning as gono-blennorrhea, afterwards pursue the clinical course of trachoma and show cell-inclusions under the microscope. The prognosis in these cases appears to be generally good, the trachoma virus being possibly influenced favorably by the gonococcal inflammation.

The virus of inclusion blennorrhea from any source, ocular or genital, has been shown to produce the same results on the conjunctiva of apes as does the trachoma virus. Further, Wolfrum has actually demonstrated the identity of the two ocular infections, infantile and adult, by producing typical trachoma in an adult with material taken from a case of inclusion blennorrhea. Heymann has succeeded in implanting the inclusion organism from the infantile conjunctiva upon a Pavian genital mucous membrane.

Naturally all these investigations need further support. We have yet to be sure that chlamydozoa are as limited in distribution as is maintained. Lindner adds some strong evidence in support of the doctrine of identity, by means of a painstaking research upon 119 cases of ophthalmia neonatorum. For the purposes of the argument, it is immaterial whether one admits the inclusions as the essential organisms or merely regards them as possibly associated parasites or reaction products. In making smear preparations, Lindner has always used epi-

thelial scrapings from the lower fornix, after carefully wiping away all discharge.

As the result, 49 cases of the series are classed as gonococcal, 53 as inclusion affections, 4 as mixed infections, gonococcal and inclusion, while in 13 cases the bacteriological findings were negative. Of the gonorrheal inflammations, 5 were one-sided; of the chlamydozoan affections, 23 were, at least for some time, one-sided. Lindner thinks that the majority of the negative results were probably in inclusion cases,the microscopical evidence failing for various reasons. In the milder catarrhal inflammations, inclusions may be so few as to require very systematic search, especially when the inflammation has become somewhat chronic. The chlamydozoan group included some of the quite acute inflammations and the large majority of the milder grades. A few mild reactions were possibly attributable to Credé treatment.

It comes as a reversal of accepted opinion to find no cases whatever attributed to the common organisms, pneumococci, streptococci, diplobacilli, etc. Such bacteria were disregarded. Lindner holds that it is very doubtful whether the recognized excitants of relatively mild conjunctivitis in the adult are capable of producing any reaction whatever in the conjunctiva of the newly-born. A few scattered organisms of this nature may well be ignored. On the other hand, Lindner is ready to accept as evidence in grouping his cases a single epithelial cell invaded by Gram-negative diplococci. The type of inflammation in which the cocci are found is presumably the justification. And the conditions are held to be as in the urethra. The normal flora of the urethra is said to be rich and varied. It diminishes to the point of extinction at the height of gonorrheal attack. Afterwards saprophytes gradually re-establish themselves as the inflammation subsides. No importance is to be attached to scattered pneumococci or streptococci found in a subsiding gonorrhea or gleet. They are not to be regarded even as constituting mixed infections, inasmuch as these organisms alone are not known to excite urethritis. In the same way such organisms as staphylococci, found in subsiding conjunctivitis of presumably gonococcal or chlamydozoan origin, are held to be of no significance.

Prophylactic measures show more brilliant results here than in any other disease. The use of vaginal antiseptics before birth lessens the danger of infection. Immediately after delivery the child's eyes should be washed with bichloride solution (1 to 8,000), followed by the instillation upon the cornea of one drop of a 2 per cent. solution of silver nitrate. This procedure, known as Credé's method has proved to be of such distinct value in preventing

gonococcal infection that in some countries its practice is made obligatory by law. See also **Blindness, Prevention of,** in Vol. II of this *Encyclopedia.*

Treatment of ophthalmia neonatorum demands the same degree of cleanliness that is called for in treating the disease in the adult. In addition to this, the application of weak solutions of nitrate of silver is called for, the strength of the solution and the frequency of application depending on the severity of the inflammation. If the cornea becomes involved, it is to be treated as in the adult.

Purulent ophthalmia not due to the gonococcus. Under this head are included all those cases of purulent ophthalmia which present the clinical signs of gonococcic infection, but in which the gonococcus is shown by bacteriologic examination to be absent.

Not only may the nonspecific forms of conjunctivitis be so aggravated by neglect and improper treatment that they assume a purulent form bearing the same clinical feature as gonorrheal conjunctivitis, but they may, without any evident reason, assume that form at any time. This may be the case in diphtheria, in Week's conjunctivitis, in pneumococcus conjunctivitis, and even in streptococcus infections.

The treatment of such cases—identified chiefly by smears and cultures—is frequent cleansing by borated or permanganate douches, the use of argentamine, or mild (1 per cent.) nitrate of silver application three times daily after cold compresses. Gently swabbing the everted conjunctivæ with sublimate, 1 to 5000, instead of the silver, is also effective.

Harman believes that the various albuminoid preparations of silver chiefly hold their sway owing to the fact that they cause less pain on application than the nitrate. To a half, one, or two per cent. of silver nitrate in distilled water he accordingly adds fifteen per cent of pure glycerine. This raises its specific gravity and greatly increases its penetrating power. It is distinctly less painful and more efficient than the ordinary solution and can be used more satisfactorily in blennorrhea than the pure nitrate.

M. H. Bell believes in full doses of silver nitrate in specific and nonspecific blennorrhea as soon as the diagnosis of a serious infection is made. Instead of waiting, as some advise, until the purulent discharge has set in, he uses it from the very commencement, on the supposition that the action of the antiseptic is mainly directed as a germicide against the bacterial invasion and before the bacteria have penetrated deeply into the mucous membrane. He has followed this rule in 15 or 20 cases and has not so far noticed a corneal involvement.

R. L. Randolph places no confidence in any of the silver salts, except

the nitrate, when it comes to gonorrheal infection of the conjunctiva. He has always held that it is a great risk to experiment with the other salts. He believes that much of the success that he has met with in treating this serious condition is due to freely "opening up" or scarifying the conjunctiva, particularly near the corneal border, treating the area just as one would an infected area elsewhere in the body. The free bleeding always betters the condition.

Kalt, who has had considerable experience in the treatment of infective conjunctivitis and keratitis with large quantities of irrigating fluids, is much in favor of calcium permanganate, which he has found very effective and non-irritating. He advises half a gramme of the salt to 1½ litres of warm, sterile water, the whole amount to be used one, two, three or four times daily. One or two additional flushings with warm sterile water may be used in the interval.

John S. Kirkendall much prefers strong solutions of silver nitrate and generally uses forty grains to the ounce of distilled water as a single application in all cases of gonorrhea of the conjunctiva, both infantile and adult. Since the adoption of this plan, years ago, he has never lost an eye or had a scar of the cornea, although previously both of these accidents occurred. He everts both lids and applies the silver solution thoroughly to the exposed mucosa, afterwards washing it off with a strong salt solution. This is followed by the use of argyrol every hour, cold applications, and thorough cleanliness. He is rarely obliged to use the strong silver solution a second time and has never seen an instance of chemosis of the conjunctiva or corneal implication of any kind following its application.

Adam has recently read a paper before the *Ophthalmologische Gesellschaft* in which he recommends the use, as a salve, of lenicet combined with euvaseline. He has found that under these applications the excessive secretion shortly decreases in amount, the number of bacteria is lessened and that the whole treatment is much more satisfactory than the classic methods commonly in vogue. Of 24 cases treated by the lenicet ointment in five only was the cornea at all affected. The salve, which goes by the name of Bleno-Lenicet Ointment, is applied every two hours and is used in from 20 to 50 per cent strengths.—(C. P. S.) See also **Bacteriology of the eye,** in Vol. II of this *Encyclopedia.*

Conjunctivitis pustulosa. (L.) Pustular conjunctivitis. See **Conjunctivitis phlyctenulosa maligna.**

Conjunctivitis, Rare forms of. In addition to the rare forms of conjunctivitis which are arranged under their proper alphabetical headings, a few peculiar forms which can hardly be given distinctive

titles have been reported by different observers. Dorff (*Klin. Monats. f. Augenheil.,* Dec., 1912) has seen two instances of a rare form of conjunctivitis caused by the action of the coeloma fluid expressed from the *Ascaris lumbricoides* on the conjunctiva. Most of the recorded cases have been seen in zoologists. Experimental studies show that the fluid causes intense chemosis with burning and swelling of the lids. The inflammation subsides in 12 to 24 hours. There is marked individual susceptibility. It belongs to the group of specific vascular poisons which only act in predisposed individuals. Its action is that of an alkaloid, probably that found by Fleury, which acts like sepsin.

Takashima (*Klin. Monats. f. Augenheil.,* Dec., 1912) describes the ocular conditions produced by the insect *Scotinophora,* found in rice fields. It produces an edema of the lids and conjunctiva, accompanied later by a muco-purulent discharge, probably induced by contact with the conjunctiva of the insect or its body juices.

Lauber (*Zeit. f. Augenh.,* vol. 30, page 462) has seen the association of follicular conjunctivitis with a giant form of *Mollusca contagiosa* involving the anus, hands and eyelids. See, also, **Bacteriology of the Eye** in vol. II of this *Encyclopedia.*

Chaillous (*Ann. d'ocul.,* cxlii, p. 196) reported an unusual form of conjunctivitis following an attack of acute otitis media purulenta. The left eye became very sore; the palpebral conjunctiva was uniformly red and the bulbar portion injected. In the inferior cul-de-sac there were rows of very large nodules, oval, with the long axis parallel to the lid margin. The caruncle was infiltrated. The follicles in the upper lid were not so large and were more uniform, more flabby and less elevated. There were no cicatrices. It was possible to exclude tuberculosis and trachoma.

Pascheff (Graefe's *Arch. f. Augenh.,* lxxi, p. 569) records a case of *conjunctivitis plasma cellularis* occurring in an eight-year-old girl. The conjunctiva of the lower lid was of a wine color, greatly thickened and fleshy. The thickening was uniform, except in one spot being slightly elevated. At the inferior fornix it increased and spread to the globe. The plica was involved and the fornix of the upper lid was greatly swollen and cylindrical. The skin of the upper lid was bulged as by a chalazion. Both eyes were affected. The bacterial investigations were negative and no trachoma bodies were found. Microscopically there was a diffuse hyperplasia of the conjunctiva markedly infiltrated with plasma cells. The hyperplastic tissue had an adenoid structure but was nowhere follicular. The disease runs a chronic course and shows a tendency to hyalin degeneration of the connective tissue and of the plasma cells.

Cosmettatos (*Trans. Eleventh Internatl. Cong. Ophth.*, 1909) described a case of *toxic conjunctivitis* in a man, twenty years of age, which came on after sleeping in a stall, on the bare ground. The condition resembled Parinaud's conjunctivitis, but differed from it in the character and form of the conjunctival growths, which were red and fleshy, with slight hypertrophy of the intervening conjunctiva. Bacterial investigations gave negative results. Histologically there was an absence of epithelium, marked leucocytic infiltration with plasma cells and macro- and phagocytes. The most likely explanation of the cause is that it was from a bite or sting from an insect.

Sakaguchi (*Sei-i-Kwai. Med. Jour.* xxxi, p. 385) gives an account of the ocular conditions produced in man by the so-called yellow moth. The symptoms consist of redness of the lids and conjunctival congestion. Experiments demonstrated that the irritation was produced by an unknown acid in the powder scattered by the moths, by the mechanical irritation of the powder, and by the combined action of the secretion from the glands of the skin.

Hilbert (*Wchnschr. f. Therap. u. Hyg. d. Auges.*, Feb., 1909) reports an instance of blepharitis and conjunctivitis in a boy of sixteen years, excited by the fresh leaves of *Marjoram*. There was intense itching accompanied by swelling of the lids with injection of the palpebral and bulbar conjunctiva and a profuse watery, mucoid discharge.

Villard (*La Clin. Ophth.*, 1909, p. 149) recorded the case of a man forty-five years of age who noticed that when he entered the vineyard at the time of vintage, he was soon attacked by an insufferable pricking of the eyes with swelling and redness of the lids. This was accompanied by irritation of the mucous membrane of the nose, bronchitis and asthmatic attacks. There were some enlarged follicles in the inferior cul-de-sac, with injection of the conjunctiva and lachrymation. Notwithstanding that the country is largely a vinous one, this is the only instance that Villard has seen.

J. T. Carpenter (*Univ. Penn. Med. Bull.*, Nov., 1908) removed a papillomatous growth of several millimeters' diameter from the conjunctiva of a twelve-year-old boy who had abraded this membrane with a stick, and Posey a somewhat similar growth also from the conjunctiva of a young boy who had sustained a slight ocular injury which had been associated with a monocular conjunctivitis. Microscopic examination of these polypoid growths made by Hosmer and Allen J. Smith demonstrated that they were the result of a localized edema, together with a polynuclear leucocytic exudate, and the presence of a large proportion of the lymphocytic type of plasma cells and some proliferation and swelling of the fixed connective tissue cells

and of the endothelium of the lymph spaces. All through the altered subepithelial tissue special parasitic bodies were found, which varied in size from 0.017 mm. to 0.33 mm. The largest bodies were filled with sporoblasts. The identity of these parasitic bodies, however, could not be determined.

Ford (*Brit. Med. Jour.,* Sept. 17, 1910) adds an instance of conjunctivitis and lachrymal concretions occurring in a woman forty-seven years of age. There was the appearance of a small cyst immediately beneath the punctum. On slitting up the canaliculus two concretions twice the size of a pin's head were found. Microscopically both were amorphous, probably inspissated mucus.

Conjunctivitis, Recurrent membranous. See **Conjunctivitis, Membranous.**

Conjunctivitis, Saltpetre. Sommer (*Wchnschr. f. Therap. u. Hyg. d. Auges.,* Feb. 6, 1908, p. 152) warns against incautious use of artificial fertilizers, as some of them are very irritating to the eye. He refers to a case of blindness reported by Augstein in 1907, and says that a mild conjunctivitis was produced in his own eyes by a quantity of "Thomasschlacke" which flew into his face as he was spreading it on a grass plot. These artificial fertilizers contain various inorganic and organic salts which dissolve readily in the tears, and are very apt to set up severe irritation of the conjunctiva.

Bondi so reports a case of acute conjunctival inflammation, the result of the accidental introduction into the conjunctival sacs of Chili saltpetre.

Conjunctivitis, Samoan. Desquamative conjunctivitis. Epitheliosis desquamitiva conjunctivæ. C. F. Ely, Surgeon to the Naval Station, Tutuila, American Samoa (*Ophthalmic Record,* September, 1914) gives the following account of this disease, quoting opinions expressed by various medical officers on duty on the island in years past, and especially the experience of Leber, an ophthalmic surgeon in medical charge of German Samoa.

"The first report is that of Dr. Rossiter, U. S. Navy, 1908. He believes that the type of conjunctivitis so prevalent in Samoa, which in lieu of a better definition is called 'Samoan Conjunctivitis,' is a distinct, acute, infectious disease, characterized by rapid onset, severe pain, photophobia, a high grade of conjunctival inflammation, soon becoming purulent, a tendency to corneal destruction over greater or less areas, and the presence in the discharge, often in pure culture, of its etiological factor, a distinct micrococcus described below.

"Geographical distribution and history:—Niue, Roratoga, New Guinea, and other island groups of the South Pacific. It is prevalent

throughout the entire Samoan group. Little can be learned of its history. It appears to have been endemic as long as the natives can recall, but to have become much more prevalent since an epidemic of morbilli which visited Samoa in 1893.

"Etiology:—In all the cases examined microscopically a micrococcus described below was found. In all but two of these cases, examined before the third day, the organism was obtained in pure culture from the conjunctiva and from the sticky, mucid discharge. In the cases where a mixed infection was found, the special organism was found in connection with the pneumococcus, or staphylococcus pyogenes aureus, or both. In no case examined, not suffering from the disease within two months, was the specific organism found. The disease is widely prevalent in Samoa, and is probably transmitted from eye to eye, and from person to person by the hands, by flies, and by dust. This type of conjunctivitis may occur at any age, but it is rare under six months and in the aged.

"Symptoms:—The exact period of incubation is undetermined, but it appears to be about 18 to 36 hours. Usually both eyes are affected at the same time, but often the disease appears first in one eye, the other becoming involved 12 to 24 hours later. The onset is with a slight roughness of the conjunctiva, slight burning sensation, mild photophobia, and a little watery discharge from the eyes. The degree of inflammation increases rapidly and within a few hours a severe form of conjunctivitis exists, in which the entire conjunctiva is deeply injected, small hemorrhages and spots of ecchymosis may be present, and there is marked photophobia, severe burning pain over the infected area, with dull intraocular pain as well. The discharge becomes sticky and mucopurulent, and the lids are glued together, and often swollen and edematous. Corneal complications are common; at first simply as cloudy infiltration, in which stage it is usually arrested by proper treatment; but in improperly treated and neglected cases, going on to ulceration and at times staphyloma and iritis. Constitutional symptoms do not appear in the milder cases. In the severer forms headache and a rise of temperature to 100 or 101 degrees F. may be present.

"Diagnosis:—The actual diagnosis must be made in the laboratory. Clinically, all the cases of acute, purulent conjunctivitis seen in Samoa, have been of this one type; but it might be confounded with most of the usual types of acute conjunctivitis, all of which, however, are rare in Samoa, or with conjunctivitis neonatorum, which on account of the rarity of gonorrhea, is necessarily rare. Within five months, of the 157 cases of conjunctivitis, under treatment, 155 were of the type

under consideration, the two remaining cases being traumatic in origin.

"Prognosis:—In early cases the prognosis is good. Where proper treatment is instituted within 48 hours, complete recovery usually results. Where corneal ulceration has taken place the prognosis depends upon the location and extent of the ulcer. The ravages of this disease in improperly treated or neglected cases are only too evident in the enormous proportion of the population of Samoa who have lost, either in whole or part, the use of one or both eyes from corneal opacities.

"Treatment:—The various salts of silver present the best method of treatment. When the first sensation of burning and roughening are felt, one or two instillations of a 5 per cent. solution of protargol will usually abort the disease. Later and before corneal ulceration has taken place, instillations of 5 per cent. solution of protargol two or four times daily will usually effect a cure in five to seven days.

"Micrococcus of Samoan conjunctivitis:—Small micrococcus about $.6\mu$ to $.8\mu$ in diameter, often seen as diplococci, and when so seen markedly resembling gonococci; the adjacent margins often being flattened. Stains readily with the usual stains. Is decolorized by Gram's method. (Control staphylococcus p. a.) Takes methyl violet to nearly black. Grows readily on usual artificial culture media, as follows:—

"Agar plates: Colonies appear in 18 to 24 hours as small, raised, opaque, moist, rounded discs, with undulate margins.

"Agar streak: Abundant, raised, white, opaque, moist growth.

"Bouillon: Uniform turbidity. Fine granular precipitate after three days.

"Potato: Abundant, raised, white, opaque, moist growth.

"Milk. Grows readily. Not coagulated after six days. No acid formation to litmus milk.

"Fermentation: No gas production in bouillon fermentation tubes.

"Gelatine: Grows readily in gelatine media, but data as to stab and plate cultures were not obtainable, owing to high room temperature, and lack of cold incubator.

"This organism will retain its vitality on any of the above mentioned media for months if moisture is supplied. Grows equally as well at room temperature, which however is high, 85-95° F., as at body temperature.

"Pathogenesis:—Found in all cases examined of Samoan conjunctivitis. Not found in healthy eyes. Although the cultural characteristics of the above mentioned organism have not been obtained for all media on account of climatic and other conditions, yet it is believed that sufficient data have been obtained as to its cultural and staining

properties to warrant the assumption that it is an hitherto undescribed organism, and that it is the sole cause of the type of conjunctivitis so prevalent in Samoa.''

Extracts from report by P. A. Surgeon Cottle, U. S. N., October, 1910. ''A chronic eyelid disease is quite prevalent in the population. The majority of the cases can be called trachoma suspects, a few we are nearly in a position to call undoubted trachoma.

''The presence of a granular eyelid disease in a population with thickened lids, cases of trachoma-like ptosis, a few of pannus, some of old adhesions between ocular and palpebral conjunctivæ, old opacities of the cornea—are signs which before coming to Samoa would to me have meant the undoubted existence of trachoma. However, the presence here of an eye disease called acute conjunctivitis (Samoan) by my predecessor is a factor as yet not entirely known. It was his tentative opinion, expressed in a report dated May 8th, 1908, that some of the conditions noted above were late stages of untreated Samoan conjunctivitis. A longer period of observation than he had is necessary before this tentative opinion can be either supported or denied.

''November, 1910. During the stay of the U. S. S. Annapolis in Apia, Cottle consulted with Dr. Leber, the German eye specialist, and had a talk with the Acting Governor, Dr. Schultz.

''The result of this conference is a complete confirmation of the opinions stated in his first partial report dated September, 1910. The German doctor does not agree with him in calling the disease trachoma. This, however, is a difference of opinion in terminology rather than in fact or conclusion, because he admits that the disease under discussion so closely simulates trachoma that he agrees in advising the same measures for the control that are used in the control of trachoma. Cottle therefore adheres to the opinion given by Dr. Connor and himself in a letter of October, 1910, stating 'trachoma is present in Tutuila and also is coming to this port from German Samoa.'

Ely's observations concerning this condition have left him open to conviction. At a later period he hopes to investigate Samoan conjunctivitis with the view of determining whether it is a separate nosological entity or trachoma. See A. Leber, Graefe's *Arch. f. Ophth.*, Vol. 87, p. 528.—(C. P. S.)

Conjunctivitis scrofulosa. (L.) Scrofulous conjunctivitis.

Conjunctivitis, Scrofulous. A form of chronic conjunctivitis attributed to scrofula; characterized by phlyctenulæ, by miliary nodules in the region of the cornea, or by serpiginous ulceration of the cornea.

Conjunctivitis sicca. Among the characteristic subjective symptoms

occurring in the course of a chronic catarrhal conjunctivitis, there is frequently the annoying sensation of dryness; the eyes can be opened only with difficulty, the patient having the feeling as if the lids were stuck to the eyeball because of lack of moisture. This same condition may accompany various nervous disturbances.

Conjunctivitis, Simple. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis, Simple acute. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis, Simple catarrhal. Peters (*Zeitschr. f. Augenheilk.*, Nov., 1907) says, "Nothing seems at first sight so easily treated as a simple, chronic catarrh of the conjunctiva. The patient generally consults, first of all, his family physician, who is likely to order a zinc sulphate collyrium for the relief of the burning and smarting and to reduce the conjunctival hyperemia. As this remedy is a specific in the diplobacillary form of the disease it may cure the patient's ill. How often does its employment aggravate the symptoms!

Even to the experienced and educated ophthalmologist the exact etiology of many instances of this affection, however well differentiated clinically, is not so easily determined. It behooves us, then, to make, by all means in our power, a careful examination of the case in all its various aspects, refractive, bacteriologic, systemic, nasal, extra-ocular and intra-ocular until we are convinced that we are able to place the disease in its proper pathological class." See, also, **Conjunctivitis, Acute catarrhal.**

Conjunctivitis, Simple granular. See **Conjunctivitis, Follicular.**

Conjunctivitis simplex. (L.) CATARRHAL CONJUNCTIVITIS. Simple conjunctivitis. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis, Simulated. CONJUNCTIVITIS ARTEFACTA. Chevallereau (*Soc. d'Ophth. de Paris,* March, 1908) reported a case of sharply defined superficial ulcers of the conjunctiva in a girl of seventeen. Tuberculin instillation produced a sharp reaction, but the conditions remained unchanged for three months, when the patient was surprised in the act of irritating the lids, and it was found that she had attempted the simulation of other diseases in previous times.

In this connection it may be interesting to refer to a case of self-inflicted burns of the conjunctiva in a young woman, recorded by Henderson. These burns were repeated on several occasions. At first they were superficial, but finally one was made so extensive that symblepharon would naturally result. This same patient had also on a previous occasion prevented the healing of a wound in her arm by inserting foreign matter into it. Henderson does not think that the eye is often selected as the medium for the exhibition of such perversion as he records, although he makes reference to some

cases described in literature, notably self-enucleation of the eyeball. Jackson has also described a patient who deliberately cut, superficially, however, her cornea with a sharp instrument, probably a pin. She was a highly hysterical woman, and also the subject of exophthalmic goiter. See, also, **Artefacta, Ophthalmia.**

Conjunctivitis, Squirrel-plague. SQUIRREL-PLAGUE OPHTHALMIA. Infection of the human eye from the so-called *Bacillus tularensis* of McCoy and Chapin, or the "Squirrel-Plague Bacillus," has been demonstrated and proved by culture methods, animal inoculations and experiments. As there is no description of squirrel-plague conjunctivitis to be found in ophthalmic literature, we quote the following from a paper read by D. T. Vail (*Michigan State Medical Society*, Sept. 10, 1914), who reports what he believes to be the first recognized case of this kind, and which presented unique, alarming and peculiar symptoms.

Before describing his own case, the author gives the following brief historical review of California squirrel-plague, which existed simultaneously with bubonic man-plague in 1900-1910, and which was at first thought to be identical with it.

Wm. B. Wherry, at that time bacteriologist for the San Francisco Board of Health and temporary assistant surgeon of the United States Public Health and Marine Hospital Services, located at Oakland, California, published an article on "Plague Among the Ground Squirrels of California" (*Journal of Infectious Diseases*, Dec. 8, 1908). It is from this article that the following historical notes are gleaned: The bubonic plague first appeared as an epidemic in the United States at San Francisco in 1900. The presumption was that plague-infected rats infesting incoming ships from the Orient found their way ashore and that they constituted the source of infection for the human cases through the fleas that they harbored. The human epidemic was at first practically limited to the inhabitants of Chinatown, San Francisco. In 1900 there were 22 fatal cases, in 1901 there were 30 cases with 25 deaths, in 1902 there were 41 fatal cases; in 1903, 17 cases died; in 1904, 9 cases with 8 deaths. All these cases were located in San Francisco. The United States officer in command of plague suppression was Surgeon Rupert Blue, the same who is in charge of the bubonic plague situation in New Orleans at this present writing (1914).

Blue first suspected in 1903 that the plague which was destroying ground squirrels in such great numbers, as was being reported from many parts of the country about San Francisco, was nothing other than bubonic plague, and he so published his suspicions to the authorities at that time, but was unable to secure dead animals for proof.

Soon, however, human cases of plague-like infection began to appear in country districts, in which no reasonable mode of conveyance other than through squirrels seemed plausible.

Take the case of Charles Bock, a country blacksmith, who came to San Francisco (August, 1903) from a neighboring village, and died of the plague. Surgeon Blue visited his town and learned that Bock had shot ground-squirrels three or four days before his illness began. The following September (1903) another victim from another part of the country died from plague, a man who had been living in a railroad camp thirty miles from civilization, and it was learned that these rough laborers often killed and ate ground-squirrels. In 1904 rural cases continued to be reported here and there, and Blue, who was keen on the suspicion that ground-squirrels were furnishing the infection, conducted a series of experiments through the aid of Assistant Surgeon Donald Currie, bacteriologist for the plague laboratory, and proved that the ground-squirrel was very susceptible to plague infection, both by inoculation and direct contact. Blue then (1904) sent a man to investigate the county of Contra Costa to ascertain the truth of the many reports that came through various sources that the squirrels were being exterminated by a plague. This agent reported that the farmers were everywhere rejoiced at the disappearance of the ground-squirrel. He also learned that the squirrels had been suffering from an epizoötic.

It was then learned by another investigator (Past-Assistant Surgeon J. D. Long) that armies of ground-squirrels were seen at different times between the years 1903 and 1905 to be migrating across the country. Farmers had endeavored to secure sick squirrels to carry home to spread the infection. They burrow the ground, feed on grain and multiply so rapidly that they had become a great pest. In fact, one man offered a bounty of $20.00 for a single sick squirrel.

After the earthquake of 1907 true bubonic plague cases appeared in alarming numbers in San Francisco. There were 156 cases with 78 deaths, and country cases continued to appear, so that Blue directed his men to trap and collect rodents from Contra Costa county that a thorough search for plague might be made. Four hundred and twenty-three ground-squirrels were sent in and among them were found four genuine cases of glandular suppurations in sick squirrels.

In spite of this, many doubted that the disease in man was contracted from squirrels. Soon, however, a case appeared in Los Angeles, which proved the direct communicability of the infection from squirrel to man without the intervention of fleas or biting insects. A boy ten years old, living in Los Angeles, found a sick ground-

squirrel near his home. Being moved with compassion, and thinking he would take it home, nurse it and make a pet of it, he picked it up, but the animal bit him on the finger. On the fourth day after he was taken very sick with fever, delirium, etc., and the glands of the axilla on that side became swollen and painful. The abscess in the armpit was aspirated, and G. W. McCoy, who was studying the case, found by experiments on guinea pigs and rats that the organism was similar to bacillus pestis. Suppurating glands appeared elsewhere, but the boy finally recovered. In view of the fact that Currie had demonstrated that the saliva from the mouth of an infected squirrel was laden with infection, due most likely to the influence of plague pneumonia that was demonstrated, it is beyond question that this boy was directly infected from the bite of the squirrel and not from flea bites.

The experiments which proved infection by direct contact and which were carried out by Currie in 1904 were as follows:

Out of six healthy squirrels that were caged with plague-sick squirrels, three died of plague. Currie rubbed the shaved abdomen of a healthy squirrel with plague-infected spleen and placed it in a cage with two other healthy squirrels. In three days the infected squirrel died of plague and the spot which had been rubbed showed plague-dermatitis. In nine days one of the two healthy squirrels died of plague and in thirteen days the other likewise died.

It was then thought by many that squirrel-plague and bubonic plague were one and the same disease. This, however, proved untrue, for Past-Assistant Surgeon George W. McCoy, of San Francisco, finally came out with a classical paper on the subject (see *Journal of Hygiene,* 1910, pages 589-601) and proved, among other things, that there was a distinct difference between true bubonic plague and squirrel-plague, the latter being less violent and the bacillus causing it being different from the true bacillus pestis, although closely allied to it (see also *Journal of Infectious Diseases,* 1909, page 676), and that fatal squirrel-plague is not identical in its pathology with fatal bubonic plague.

Finally, in 1911, McCoy and Chapin (*Journal of Infectious Diseases,* 1912, page 71) identified the germ of squirrel-plague, grew it on egg-yolk culture, proved its entity, described it fully and named it bacillus tularensis after the county of Tulare, in California, in which the disease was first observed. They state "the essential pathological lesions (of fatal squirrel-plague infection in rodents) are many whitish or yellowish caseous granules in the spleen and liver." Caseous nodules also appear in the lymph glands.

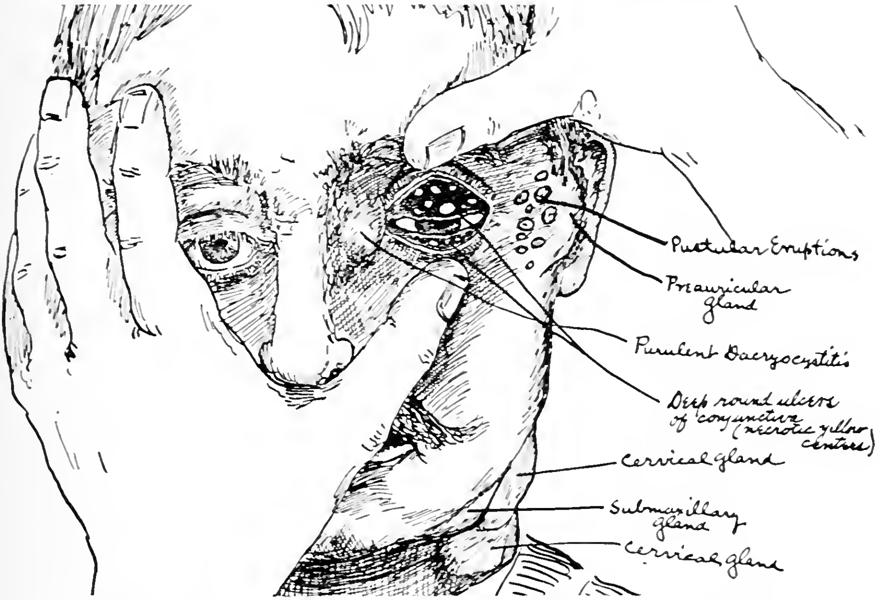
Vail then gives the following account of his case: E. E., male, aged 28, referred to the writer on November 24, 1913, by Dr. Paul DeCourcy, of Cincinnati, on account of an acute and violent inflammation of his left eye. Occupation: Meat cutter in restaurant. Family History: Negative. Personal History: Measles at age of 7, mumps at age of 7; no other illness. Denies venereals. Present Illness: Three days ago left eye became inflamed and swollen. Tried medicine prescribed by a druggist, but eye became rapidly worse. The lid margins were agglutinated mornings. Notices a "sore lump" in front of the left ear. Eye discharges much watery secretion. Has no pain; vision unaffected. External inspection: Right eye, normal. Left eye: Marked redness and swelling; intense chemosis is present; eye discharges muco-watery secretion; lashes are matted, tuft-like; general appearance of eye suggests gonorrheal ophthalmia; the pre-auricular gland on that side is swollen to the size of a small cherry and is tender to touch; cornea, clear; tension, normal; iris, normal; pupil, normal in size and reaction; dioptric media, clear; ophthalmoscopic examination, negative; vision, normal. Palpebral conjunctiva: on everting the eyelids, the seat of disease is revealed. The conjunctiva is riddled with about ten discrete deep, round, yellow necrotic ulcers, that run clear through the substantia propria of the conjunctiva quite to the tarsus. There are six such round ulcers over the upper tarsus and four at least over the lower tarsus. The ulcers appear punched out, but filled with golden yellow necrotic plugs. Size varies from 6 mm., the largest, which exists near the upper edge of the tarsus of the upper lid, to about 1.0 mm. The surrounding conjunctiva is deep-red, very soggy and swollen, but does not bleed on being wiped with a wet cotton sponge. The necrotic plugs in the beds of the ulcers cannot be wiped away. The contrast between the deep-red color of the conjunctiva and the brilliant-golden color of the ulcers is as striking as a turkey-red calico dress with yellow "polka dots."

A smear was taken at once to search for the gonococcus, but none found. Cultures in nutrient agar and blood serum made, but nothing beyond mixed infection revealed after 48 hours. Patient warned as to the likely contagious nature of his trouble, and was taught how to cleanse his eye and treat himself with the antiseptic and astringent washes and the yellow oxide of mercury ointment which were prescribed. A diagnosis of Parinaud's conjunctivitis tentatively made.

On the next day the eye was worse, patient pale, temperature 100, pre-auricular gland more swollen, the lymph glands of the anterior triangle of the neck and submaxillary region of that side are easily

felt to be enlarged and are tender. The diagnosis of Parinaud's conjunctivitis was withdrawn on account of the ulcers; the process seemed too acute for tuberculosis and it was certainly not chancroid or true chancre.

The patient now lost weight rapidly, looked cachectic and sick, temperature 102, glands of the left side face and the neck were conspicuously large and now there is seen a discrete pustular eruption six or seven in number and 4 to 5 mm. in size, something like the



Necrotic Lymph Nodes in Squirrel Plague Conjunctivitis. (Vail.)

pustules of varicella, located on the left temple and malar region. The appearance of the left eye is not improved; cornea is, however, brilliant and vision unaffected. The left nostril discharges a watery mucus freely. The left turbinated bodies are swollen and red. On account of the nasal symptoms and the pustular eruption on the left malar, the diagnosis was changed to glanders or farcy and patient urged to go to the hospital, where he could get the benefit of proper treatment and laboratory diagnosis, but he declined this. A new symptom developed in two days, viz., infection of the left lachrymal sac with every evidence of abscess formation.

The ulcers of the conjunctiva remain about the same in appearance, but are slightly more numerous. They are not epithelial ulcers, such as we see in herpes, but perforate the conjunctiva quite to the tarsus.

Evidently the solitary lymph nodes of the conjunctiva are the seat of the necrosis. The accompanying sketch was made to illustrate the appearance of the case at this time.

Robert Sattler now saw him and made the following clinical memoranda: Right eye: Normal. Left eye: Lids puffed and reddened; swelling size of hazel-nut at inner canthus (purulent dacryocystitis); ocular conjunctiva much congested; on eversion of the lids the palpebral conjunctiva much thickened, roughened and reddened; conjunctival ulcers are present; pressure on tear sac, which has consistency of well-filled bladder, does not evacuate it into the eye or nose; there are a half-dozen large pustules between the left eye and ear; the anterior auricular and anterior cervical glands and those about the angle of the jaw are enlarged; there are no glandular enlargements at the right side of the face. Lungs: Negative. Heart and circulatory apparatus: Negative. Abdomen: Negative. Extremities and genitalia: Negative. December 9: Abscess of the tear sac incised, discharging yellow, creamy pus. December 10: Drainage from the abscess has ceased; conjunctival ulcers gone; ocular condition much improved, but the pre-auricular and other glands remain enlarged. December 11: Patient discharged, improved; the temperature chart shows the typical rise and fall of a general septic infection, highest being 102.6, evenings of December 4 and 5, but the morning temperature never below 100 until after December 5. Several unsuccessful attempts were made to see the patient after he left hospital, but all that could be learned was that he was well again and at work.

It has been proven by various students of the disease—Blue, McCoy, Chapin, Currie, Long, Wherry, and others—that all rodents are susceptible to infection by direct contact, squirrels and rabbits particularly so, and it is probable that this patient was directly infected from one of these animals, probably exposed for sale as food.

Three facts are significant:

Wherry (*Journal of Infectious Diseases*, Sept., 1914) says that "a year previously (to this case) we had heard from a hunter that wild rabbits were dying in large numbers across the Ohio River in Kentucky." Moreover, this man was infected during the hunting season when the market is open to the sale of rabbits.

Health Officer Landis, of Cincinnati, learning the markets of the city were selling rotten rabbits, investigated and found large quantities of putrid rabbits on sale at five cents apiece. He rightly condemned all of them and reports that 36,420 pounds of decayed rabbits were seized and destroyed between November 1 and December 6, 1913. The patient was infected in the height of this season.

Moreover, he is by occupation a meat cutter in a cheap restaurant located in the tenement and slum district of the city close to the markets. The inference is fair that rabbits affected with caseous buboes came to his table for cutting, that he held the diseased meat in his left hand, cutting with the knife held in his right hand, and that he introduced the poison into his left eye from his left finger. There is, of course, no direct proof of this.

Conjunctivitis, Staphylococcus. A peculiar inflammation of the conjunctiva following a normal cataract operation was observed by Lerperger (*Zeit. f. Augenh.*, vol. 30, p. 247). Fifteen days after healing of the wound staphylococcus inflammation of the conjunctiva occurred. The conjunctiva had a peculiar gelatinous appearance with a profuse mucoid discharge. A few days later iridocyclitis developed with a parenchymatous infiltration of the cornea. Pannus subsequently formed. Four months later epidermal-like degeneration of the tarsal conjunctiva followed, and gradual shrinking of the conjunctival sac took place.

An unusual case of staphylococcus conjunctivitis has been described by Wilder and Davis (*Trans. Amer. Ophth. Soc.*, vol. 13, page 377) occurring in a poorly-nourished colored woman forty years of age. The fellow eye became affected six months later. The fornix was thickened and bulging and had a large ulcerated surface covered with peculiar greenish crusts resembling some copper salt and firmly adherent to the underlying tissue. This rapidly reformed after removal. Smears showed cocci resembling staphylococci. No parasites or fungi were found. Microscopic study showed masses of cocci surrounded by necrotic tissue beyond which was a pyogenic membrane. The greenish exudate was composed of pus cells and hyaline-like substance in places distinctly greenish in color. Close to the margins of these subepithelial masses were giant cells. Culture gave pure staphylococcus. Subcutaneous inoculation in guinea-pigs gave localized abscesses. The characteristics suggest some peculiar chromogenic character either of the tissues or of the organisms.

Conjunctivitis, streptococcus, Bacteriology of. See **Bacteriology of the eye.**

Conjunctivitis strumosa. (L.) Scrofulous conjunctivitis. See **Conjunctivitis scrofulous.**

Conjunctivitis, Strumous. Scrofulous conjunctivitis.

Conjunctivitis, Sub-acute catarrhal. Morax-Axenfeld conjunctivitis. This form of conjunctivitis is attributed to a particular microorganism which was found by Morax in 1897, and since has been studied by Axenfeld, Gifford and others. This germ is a diplobacillus, two

or three micromillimetres long and about one-half as thick, appearing as two short rods, separated by a clear space, and can be distinguished from the pneumococcus by having no capsule and appearing more rod-like (see figure). Gifford, however, believes it to be encapsulated. Morax found that a pure culture of it, carried through the fifth generation after incubation, causes typical inflammation in the human conjunctiva, but is not pathogenic for animals. It stains with dilute carbol-fuchsin and is decolorized by Gram's method.

Morax-Axenfeld conjunctivitis presents in many instances a characteristic clinical picture. The subjective symptoms are, as a rule, mild,

Morax-Axenfeld Diplobacillus.

the patients complaining sometimes of pain in the eyes, epiphora, and headache, which is worse at night. The disease is found in all ages, but is particularly frequent in old age. Both eyes are usually affected. The onset is sudden.

A typical case of Morax-Axenfeld conjunctivitis begins as a mild catarrhal conjunctivitis in one eye, the other eye soon becoming involved. The conjunctivitis increases in severity, and in twenty-four to forty-eight hours there will be seen marked reddening of the lids, especially at the outer and inner canthi, some maceration of the skin, and in the conjunctival sac a varied amount of watery discharge which gives the reddened lids a moist appearance. The blepharitis, with the reddening at the outer and inner canthi, makes the picture a marked one. The palpebral conjunctiva is more involved than the bulbar. It

is generally only a "palpebral conjunctivitis." In many cases the form of conjunctival infection shows these characteristic symptoms, and in such cases a temporary diagnosis may be made from the clinical signs; but it is to be remembered that many cases showing a like clinical picture will present themselves where the etiologic factor is a very different one. No disease of the conjunctiva presents at times such a typical, characteristic appearance as does this form, but at other times the clinical picture will give one no indication that the infection is diplobacillary (McKee).

The disease may appear as a mild catarrhal conjunctivitis, where the patient complains of headache and pain in the eyes, especially when reading at night; or the conjunctivitis may be attended with some slight reddening at the outer and inner canthi (angular conjunctivitis). The catarrhal conjunctivitis may have an accompanying blepharitis (blepharo-conjunctivitis), and there may even be an acute purulent conjunctivitis.

The headache, which is more severe following close work and in the late afternoon and evening, naturally leads us to seek some error of refraction as the cause, as, for example, a case reported by McKee of a young man engaged in office work who complained of headaches which were especially severe towards evening. His refraction, examined under a cycloplegic, was found to be normal. There was no muscular error and no pathological conditions in the fundi. Examination revealed a mild conjunctivitis, and diplobacilli were found in numbers. Under appropriate treatment his symptoms were completely relieved in two weeks. Quite a number of similar cases have been reported.

For the treatment of this form of conjunctivitis, it has been very conclusively demonstrated that the chloride of zinc exerts a powerful influence on the diplobacillus. This preparation is used in solutions of 0.2 to 0.4 per cent. strength, and should be used three times a day. The general conditions under which the patient lives should be regulated as far as possible as in the treatment of the other forms of acute conjunctivitis.—(C. P. S.) See, also, **Conjunctivitis, Morax-Axenfeld.**

Conjunctivitis suppurativa. (L.) Purulent conjunctivitis.

Conjunctivitis, Swimming-pool. NATATORIUM CONJUNCTIVITIS. Huntemüller and Paderstein (*Deutsch. med. Wochenschr.*, January, 1913) report a series of 14 cases of acute conjunctivitis of striking resemblance to acute trachoma. The patients had all bathed in a public natatorium. Only the fact that in short succession two attendants of the same swimming bath were affected aroused the suspicions of a natatorium endemic as described by Schultz and Fuchs. The infectious

nature of the disease was proved by its transmission to monkeys. The secretion contained typical cell-inclosures very similar to the chlamydozoa found by Halberstaedter and Provazek in trachoma.

Further investigations must decide whether this affection is a disease sui generis, or genuine weakened trachoma. The authors incline to the first assumption. The natatorium-conjunctivitis does not always heal completely, but may leave changes which also occur in trachoma, e. g., ptosis. It must, however, be emphasized that of the two pathognomonic symptoms of trachoma, the most important, viz., cicatrization, was found in no case and the significance of pannus in one patient was doubtful. The water of the natatorium was daily renewed and the tank was thoroughly washed with antiseptic solution once a week, so that it may be supposed that all morbid agents were destroyed. Hence the contagion could only occur through bathing water which was recently infected.

Conjunctivitis, Symptomatic. One of the non-specific forms of conjunctivitis, which usually accompanies eye-strain. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis syphilitica. (L.) Syphilitic conjunctivitis.

Conjunctivitis tarsalis. (L.) Palpebral conjunctivitis.

Conjunctivitis, Tea-leaf. A form of conjunctivitis produced by the erroneous method of attempting to cure an inflamed eye by the application of a poultice made of tea-leaves. See **Conjunctivitis, Acute catarrhal.**

Conjunctivitis, Tonsillar. It is not infrequently observed that certain obscure and recurring inflammations of the eye are due to soluble toxic products from diseased tonsils, adenoids, or cervical glands, which reach the eye by the lymphatics or the general circulation. Parsons and others incline to the belief that phlyctenular conjunctivitis and keratitis are due to endogenous toxins.

The term *tonsillar conjunctivitis* is used by Alexander (*Ophthalmology*, July, 1912) to designate those forms of conjunctivitis which are produced by toxic products which have originated in diseased tonsils. In support of this theory he reports the case of a little girl who had an obstinate recurrence in a long series of such inflammations. Examination showed a strongly positive Moro and von Pirquet reaction, as well as enlarged posterior cervical glands. He found the tonsils deeply imbedded, and in operating uncovered a collection of soft creamy white exudate under the plica triangularis. Within a few hours after the tonsillectomy the eye had cleared, and within two weeks the glands of the neck were not palpable. No

recurrence had taken place during the last eighteen months.—(C. P. S.) See, also, **Conjunctivitis, Toxic.**

Conjunctivitis, Toxic. DRUG CONJUNCTIVITIS. ATROPINE CONJUNCTIVITIS. CONJUNCTIVITIS FROM ESERINE, ANILINE, CHRYSOPHANIC ACID, DUBOISINE, HOMATROPINE AND HYOSCINE.

A rather uncommon form of conjunctivitis is caused by the application to the conjunctiva of certain medicines: atropin, cocain, homatropin, hyoscyamin, duboisin, eserin, arecolin, etc. This disease is characterized by the presence of follicles, which are found in greatest abundance usually in the lower fornix. The toxic effect of the drug may follow a single application or may come only after prolonged use of it. When the effect comes on, immediately the skin of the lid becomes dry, red, and swollen, and may appear like erysipelas. This type of the disease is more often found in adults than in children. In the second form, after long use of a mydriatic or miotic, there is the sudden appearance of an acute catarrhal conjunctivitis with mucopurulent discharge.

The cause of this affection is considered by Glorieux to be a paralysis of the vasomotor nerves, with sequent dilation of conjunctival vessels. In some cases idiosyncrasy is undoubtedly a factor. An impure chemical solution or the presence of germs in the solution employed is a frequent cause.

The treatment of this condition consists in the discontinuance of the drug. Cold applications of the dilute subacetate of lead, or tannin and glycerine solutions, are valuable remedies. In atropin conjunctivitis, de Schweinitz uses a one per cent. solution of creolin. The skin of the lids should be smeared with the ointment of ammoniated mercury (1 in 20).—(C. P. S.)

Conjunctivitis, Toxic-endogenous. Because of the disagreement in the results of the experiments on this subject by Valenti and Tschirkowski, Cavara (*Ann. di Ott.*, vol. 20, p. 569) conducted a series of experiments on rabbits and cats and comes to the following conclusions: The toxins of the bacterium coli dysentericum, Celli, and that of Kruse exert a toxic action on the conjunctiva of certain animals, but do not produce endogenous conjunctivitis when introduced at a distance from the eye, even when a locus minoris resistentiæ has been artificially established in the conjunctiva. An elective action of these bacteria for the conjunctiva and lachrymal gland was negatived. Tests for the deviation of the complement failed to show any fixation of the toxins by either conjunctiva or lachrymal gland.

Conjunctivitis trachomatosa. (L.) Granular conjunctivitis. See **Trachoma.**

Conjunctivitis, Trachomatous, Bacteriology of. See **Trachoma,** also **Bacteriology of the eye.**

Conjunctivitis, Traumatic. After the action of irritant substances upon the eye, an acute *traumatic conjunctivitis* is produced, evidenced by the intense reddening of the conjunctiva, with great photophobia, lachrymation, and pain, with which is associated in violent cases an edematous swelling of the lids. Such irritant substances are acrid vapors, liquids, or dust-like particles, which get into the eyes either by accident or as a part of the day's work in certain industries. For the physician, it is important to know that chrysarobin, which, used as a remedy (especially for psoriasis), may cause an acute conjunctivitis, and in that case, therefore, must be discontinued. Under the same guise of an acute traumatic conjunctivitis appears and runs its course that form of conjunctival inflammation which develops in consequence of the action of intense light, as, for example, after dazzling by the reflection from snow (*snow-blindness*), or by the electric arc light (*ophthalmia electrica*). In very severe cases of this sort there are found besides the inflammation of the conjunctiva, contraction of the pupil and also slight opacities and erosions of the cornea. These symptoms, like the erythema of the skin occurring as a result of insolation, are produced by the action of the ultra-violet, chemically active light rays (Widmark). These cases of traumatic conjunctivitis, in spite of the violent symptoms which they present in their beginning, generally get well within a few days without further bad results.

Pfalz (*Klin. Monatsbl. f. Augenheilk.*, Vol. XLIX, Nov., 1911) believes that the chronic hyperemia following traumatic conjunctivitis is of no importance and will gradually disappear without leaving a tendency to reinfection. Traumatic conjunctivitis heals spontaneously in a few days. Continued inflammation is an evidence of infection. In burns of the conjunctiva of the third degree it is an error of technic to neglect transplantation. Astringents should never be used in burns of the first and second degree. They irritate and do no good. Prolonged treatment is apt to cause a treatment neurosis. If trachoma develops after a traumatic conjunctivitis, it is due to a previous infection.—(C. P. S.) See, also, **Conjunctivitis, Acute contagious.**

Conjunctivitis, Tubercular. This condition may be present, as a primary affection, in persons who show no evidences of its existence elsewhere. In such cases it is due to direct infection, through an abrasion of the epithelium, by a foreign body, following an operation, or through the breaking of a phlyctenule. This last cause seems the

more probable since the disease is found most frequently in childhood. In rare cases the ulceration passes over the edges of the lid to the integument, but usually it stops at the inner edge. The tubercle bacillus is found in most cases, yet there are exceptions. The disease first manifests itself by a thickened appearance of a portion of the conjunctiva with one or more yellowish nodules, some of which may already be in a state of ulceration. Any portion of the conjunctiva of the ball or lids or retro-tarsal folds may be affected, and the nodules vary in size from that of a pin-head to a destruction of tissue embracing almost the entire surface of the conjunctiva.

The disease is chronic in its course and in most cases it remains a purely local affection. For the more complete description of this form of conjunctivitis, in its clinical and bacteriological aspects, the reader is referred to **Conjunctiva, Tuberculosis of the,** in Vol. IV of this *Encyclopedia.*

Conjunctivitis tuberculosa. (L.) See **Conjunctiva, Tuberculosis of the.**

Conjunctivitis, Uratic. CALCAREOUS CONJUNCTIVITIS. LITHIASIS OF THE CONJUNCTIVA. This disease is associated with the gouty or rheumatic diathesis, and is characterized by a deposit of crystals of uric acid or sodium urate in the acini of the Meibomian glands. Patients suffering with this disease complain of a pricking sensation in the eyes and a feeling of a foreign body under the lids. Examination shows the deposits existing as numerous small concretions of a yellowish-white color. Both the palpebral and bulbar portions of the conjunctiva are hyperemic and the anterior scleral vessels are engorged. The disease is more common in elderly than in young subjects. According to Herbert, who has carefully studied the conjunctival changes produced by chronic inflammation, "lithiasis," he considers as infarcts of the Meibomian glands, and "mycosis" as cyst formations sequent to the closing of epithelial tubules. The downgrowth of these tubules is found not only in papillary trachoma, but also in all forms of chronic conjunctivitis. The cheesy material found in these cysts results from the accumulation and degeneration of epithelial and wandering cells. The treatment consists in removing the crystallized masses with a cataract-needle under cocain anesthesia. This treatment is to be followed by the use of a boric acid wash locally and the internal administration of the salts of lithia. Attention to the general health is required in these cases. The disease is prone to recurrence.—(C. P. S.) See, also, **Conjunctiva, Lithiasis of the.**

Conjunctivitis variolosa. (L.) A form of conjunctivitis occurring in connection with variola. Hyperemia of the conjunctiva usually accom-

panies variola. The conjunctiva may show a catarrhal form of inflammation about the fifth day of the eruption which readily yields to simple treatment. The intensity of the conjunctivitis is in proportion to the involvement of the face and eyelids. Pustules rarely form upon the conjunctiva; when they occur they resemble phlyctenulæ. A favorite site for the pustules is the area between the corneal margin and the inner or outer canthus. Pustules may appear on the limbus, in which event corneal ulceration is likely to supervene. Pustules may form on the tarsal conjunctiva and on the caruncle, but are never found at the fornix (Chance). In the pustular type of variolar conjunctivitis severe inflammatory symptoms, such as chemosis and profuse discharge, are present. Subconjunctival hemorrhages may occur in hemorrhagic variola.

Mild antiseptic solutions should be used in this variety of conjunctivitis. (Ball.)—(C. P. S.)

Conjunctivitis, Vernal. SPRING CATARRH. VERNAL CATARRH. FRUEJAHR'S CATARRH. PHLYCTENULA PALLIDA. SAEMISCH CATARRH. CIRCUMCORNEAL HYPERTROPHY OF THE CONJUNCTIVA. This is a rather uncommon disease, characterized by thickening and marked roughening of the palpebral conjunctiva and by the presence of an exudation into the corneo-scleral margin, causing an elevation and uneven surface in this location, dirty gray in color, varying from one to three millimetres in breadth, with an appearance not unlike an exaggerated arcus senilis. Peripheral opacities of the cornea also are present. Subjective conditions, as stated by the victims of this disease, are as characteristic as objective changes. Little or no annoyance from the eyes is experienced during the winter, but with the advent of the first warm days of spring the eyes begin to grow red and to water; photophobia and a constant itching of the eyes greatly annoy the patient. In autumn the troubles once more abate, disappearing completely in cold weather, only to begin anew the following spring.

The disease was first described by Arlt in 1846 as *conjunctivitis lymphatica,* but it seems to have escaped detection as a distinct conjunctival affection until Saemisch again called attention to it, in 1876.

Meyerhof (*Klin. Monatsbl. f. Augenheil.,* June, 1912) considers vernal catarrh to be an hereditary disease, probably through a congenital predisposition toward the affection, and bases his assumptions upon the many cases he has seen in many members of the same family. Schmeichler (*Wiener Klin. Wchnschr.,* No. 1, 1908) has observed what he considers a rudimentary form of the disease in children. It consists of hyperemia in the region of the palpebral fissure and a very slight proliferation at the limbus. It appears in warm weather,

is accompanied by some itching and disappears upon the advent of cold weather. The difficulty of a differential diagnosis of a vernal catarrh superimposed upon an old trachoma is discussed by Meyerhof, together with a report of some twenty-five cases of his own. The presence of the vernal can be proved, however, both clinically and anatomically. Itching is regarded as an important diagnostic sign. Cosmettatos (*Arch. f. Augenh.*, vol. 68, 1908) reported a case of vernal catarrh closely resembling trachoma. It was differentiated by the milky appearance of the conjunctiva, the itching and its periodicity as well as by the anatomic picture. Another typical case of vernal catarrh is mentioned by Beard (*Ophth. Rec.*, xx, p. 216), who describes a unilateral disease of the mixed type in a young woman 26 years old. The involvement of the plica semilunaris in the form of a thickening is an unusual complication described by Seefelder (*Klin. Monats. f. Augenh.*, p. 766, 1911). Histologically, a sclerosis of the substantia propria was present, together with a cellular infiltration with plasma cells, eosinophils, lymphocytes, fibroblasts and mast cells. Feldmann (*Centralb. f. p. Augenh.*, p. 127, 1909) found that of eighty-one cases of vernal conjunctivitis treated in seventeen years at the Griesner Eye Clinic, 79 per cent. occurred in males, and the majority between the ages of six and fifteen years. The disease lasted from four to six years. In a single instance, nine years. He believes sunlight to be an important factor in its causation, this accounting for its greater frequency in males.

Its usual seat is the upper margin, though it may show itself at the sides and sometimes completely encircles the cornea. Its seat is just within the corneo-scleral margin, but in pronounced cases it nearly always extends for a considerable distance on the corneal surface itself. The bulbar conjunctiva seldom shows pronounced injection, though there may be an active hyperemia in the immediate vicinity of the elevation. An examination of the base of the elevation with a magnifier will nearly always show small capillaries entering its substance. The cornea inside of this elevation is not affected. The conjunctiva of the lids is always hyperemic, slightly swollen, and its surface is covered with very minute granules like dust of meal, although sometimes they are quite large and very hard (Schiele). The conjunctival surface has often the appearance of being covered with a thin layer of milk. In negroes the bulbar conjunctiva shows a brownish tinge, in some instances very pronounced, corresponding to the palpebral opening, and specks of brown are often noticed in the gray elevation around the corneal base. The conjunctiva of the ball looks thick and soggy and is easily thrown into folds parallel with the base of the cornea.

The exact pathology of the disease has not been determined. It appears, however, to be a proliferative and degenerative affection of the epithelial layer of the conjunctiva, including that of the cornea at its base. It is considered by some to be of an eczematous nature. The elevation around the base of the cornea consists almost entirely of proliferated epithelial cells, arranged in a peculiar manner, not unlike the plugs of a cancroid (Burnett). A section of the large granular bodies sometimes found on the palpebral conjunctiva shows a stroma, for the most part of lymphoid cells, traversed by scanty bands of connective-tissue fibres. The tissue is rather vascular. The epithelium covering it is thickened and runs like pouches into the interior. The anterior layers of the cornea are usually implicated to some degree. No microbe peculiar to it has yet been found. Cases sometimes occur in which the circumcorneal changes are so slight as to escape any but the most careful scrutiny, the appearances of the other portions of the conjunctiva being characteristic and the clinical symptoms typical of the disease. In other cases the surface of the palpebral conjunctiva will be covered with flat-topped papules resembling cobble-stone pavement, polygonal by mutual pressure; they are often of cartilaginous consistence. They may be several millimetres in diameter, and are often broader than they are high. In vertical section, the papillæ have the shape of the circumvallate papillæ of the tongue. The growths are rather of the nature of fibromata than papillomata (Spicer). The disease may be confined to one eye, but usually affects both. When the disease subsides, it leaves no trace behind, except a narrow band of slight opacity on the surface of the cornea, that can sometimes be detected on close inspection. Thus far it has not been possible to associate it with any special dyscrasia, though in some cases an enlargement of the glandular system has been noted. It occurs mostly in children and young people, though it is found not infrequently in adults. It has been thought by some (Chibret) to be an attenuated form of trachoma. Anything like a close connection between the two, however, remains to be proved.

Eosinophile cells are often found, although not constantly, in the conjunctival proliferations. They are very numerous in the conjunctival secretion. Alterations in the blood are found; for example, an absolute increase in the white corpuscles and a relative increase in the number of lymphocytes. If the granulations are excluded from light, they diminish in size and sometimes disappear, but this does not mean that light is actually the active agent in the production of the proliferations. Tchistiakoff (*Viestnik Ophth.*, xxvi, p. 218, 1909) found hypertrophy of the epithelium and especially of the stroma

with hyalin degeneration of the connective tissue. Blaauw (*Ztschr. f. Augenh.*, xxii, p. 317) found eosinophiles present. He states that these cells are pathognomonic of this affection; the only other conditions in which they are found, according to Axenfeld, being pemphigus, infection with trypanosomes, or with parasites (myiasis).

Gabrielides (*La Clin. Opht.*, Jan. 25 and May 25, 1908) made a histological examination of the lesions of a case of spring catarrh (proliferating tarso-conjunctivitis) which had existed for eighteen months in both eyes of a young man aged seventeen. The preauricular glands were swollen. The lesions found did not differ from those which have been elsewhere reported. He found, amongst other conditions, a large number of eosinic polynuclears in a piece of the excised conjunctiva.

C. Pascheff (*Arch. d'opht.*, Aug., 1908) has found a migration of Ehrlich's mast cells in cases of vernal catarrh. They occur abundantly in the epithelium and also in the conjunctival secretions. They are also found in the connective tissue, and especially in close relation to the blood vessels. Their migration is not peculiar to vernal catarrh, but is much more extensive in this malady than in any other form of conjunctivitis.

Maggi (*Arch. di Ott.*, xix, p. 415) examined thirty-eight cases of vernal catarrh, and always found a very large number of eosinophiles. In 50 per cent. of the cases he found some symptoms of Angelucci's syndrome present. His method of treatment is continuous bandaging, which, however, is only of transitory value. Pusey (*Jour. Am. Med. Assn.*, Oct. 7, 1911) examined the conjunctival scrapings from a series of cases of vernal catarrh during the summer months with the Giemsa stain, which gives a clear picture of the eosinophiles. Thus he found many cases of the disease that would have been otherwise overlooked because of lack of clinical symptoms. He regards the presence of eosinophiles as diagnostic, and claims that they are not found in other affections of the conjunctiva. Because of the close resemblance of hay-fever and vernal catarrh, Pusey examined the conjunctival scrapings from a series of cases of true hay-fever and found many eosinophiles. He consequently offers the hypothesis that there may be the same cause underlying both diseases, namely pollen. Rübel and Bayer (*Klin. Monats. f. Augenh.*, Nov., 1911) also found an increase in the eosinophilic content of the conjunctival sac during hay-fever.

The chief clinical peculiarity of the disease is its appearance with the first warm days of spring or early summer, and its disappearance at the beginning of cool weather; whence the name *vernal* or *spring*

catarrh. In some rare instances, however, the disease continues with diminished intensity during the winter. It makes its appearance again at the beginning of warm weather, and may do so for several years in succession. It occurs in all grades of society and does not seem to be influenced by occupation or by exposure to the rays of the sun. It is sporadic and noncontagious.

The patients complain of the usual symptoms of conjunctivitis. These are burning and itching sensations, heaviness of the lids, photophobia, and lachrymation. There is sometimes a slight mucous discharge, though this is not an invariable accompaniment. The conjunctiva presents a bluish-white color, resembling a film of milk spread over the membrane. In England and France the tarsal type is prevalent, while in Italy and other Mediterranean countries the bulbar form is more often observed. The patient often has a dull, sleepy look, owing to the slight ptosis which is present.

It must be differentiated from trachoma and from phlyctenlar conjunctivitis. Spring conjunctivitis should not be confounded with the conjunctivitis attending hay-fever, which presents more of the anatomic and few of the symptomatic points found in vernal conjunctivitis. The pericorneal elevations of vernal conjunctivitis are permanent or of long duration, and they do not break down and leave ulcers. These characteristics will prevent the confounding of this disease with phlyctenular conjunctivitis. Occasionally the bulbar type of vernal conjunctivitis, with a single tumor-mass, can be differentiated from sarcoma and epithelioma only by a microscopic examination.

The prognosis is favorable in the sense that the disease does not cause serious lesions of the cornea. It is a disease of long duration, and may recur every summer for many years. The bulbar variety offers a more favorable prognosis than the tarsal type.

Bacteriological examination in the reported cases of spring catarrh has revealed only the every-day inhabitants of the conjunctival sac. Even in the secreting cases Axenfeld has not made any findings of etiological value (McKee).

Pascheff (*Arch. d'opht.*, Aug., 1908) has isolated a micro-organism from several cases of vernal catarrh. The organism is a bacillus, resembling the pseudo-diphtheria bacillus and especially that of xerosis. It is distinguished by the following characteristics: (1) The possession of a capsule not stained by ordinary methods; (2) its growth at ordinary temperature in stab gelatin cultures; (3) its production of acid; (4) its pathogenicity for the vitreous humor. The bacillus forms small colonies on the affected conjunctiva, appearing there as small, whitish points.

F. Lagrange (*Arch. d'opht.*, Nov., 1908) reports a case of vernal catarrh, remarkable for its extensive involvement of the cornea. Histologic examination of an excised piece of the cornea showed that the inflammatory process did not involve the epithelium, but affected the corneal tissue proper, which was the seat of a connective tissue proliferation. The tarsal cartilage also participated in the formation of granulations. Another feature was the abundance of eosinophiles, both in the tissues examined and in the secretion.

Brav (*Therap. Gaz.*, vol. 29, p. 247) has not observed the so-called milky cover usually described in vernal conjunctivitis.

Posey (*Ophth. Record*, vol. xxii, p. 263) records an instance of a type of vernal conjunctivitis which he considers extremely rare: pale pinkish, waxy, more or less rounded excrescences persisting for years during cold weather.

Elschnig (*Wiener Med. Wchnschr.*, No. 2, 1908) calls attention to an arrangement of the blood vessels of the tarsal conjunctiva which he considers peculiar only to spring catarrh. With the loupe he found the normal vascular arrangement replaced by innumerable small vessels arising perpendicular to the conjunctival surface from the deeper portions of the conjunctiva. To the unaided eye the conjunctiva has the appearance of being studded with red dots. In every one of the six cases he has seen during the past three years this condition was present.

The treatment consists in the use of simple antiseptic collyria, the use of amber protective glasses, and the attempt to relieve the distressing symptoms and stop the encroachment of the disease upon the cornea. Believing that the ultraviolet rays are important factors in the development of the disease, Axenfeld suggests that the lids should be covered with an impermeable varnish containing quinin, or that protecting glasses containing a solution of the drug, which destroys the ultraviolet rays by changing them into fluorescent rays, be worn. All manner of drugs have been used for the purpose of giving relief, notably dilute acetic acid, adrenalin, salicylic acid, ichthyol and antipyrin. Massage, X-rays and radium have frequently been tried, but in spite of all treatment Axenfeld maintains that he knows of no case having a duration of less than four or five years.

L. Webster Fox recommends as a radical treatment of vernal conjunctivitis that the exposed granulations shall be thoroughly scarified with a three-bladed scalpel and the tissue afterwards scrubbed with a toothbrush which is steeped in corrosive sublimate, 1 to 5,000. In other words, he undertakes a radical cure by means of grattage.

Twelve cases treated in this way resulted in a permanent cure in ten. In one case the operation had to be repeated, and in another case the operation gave relief for some weeks, after which the disease returned.

Ludwig Vermes (*Klin. Monatsbl. f. Augenheilk.*, Sept., 1908) believes that the good results obtained by Kreibrich in Frühjahr's katarrh by shutting out the light, which have been confirmed by others, prove that light must be one of the most important etiological factors in the causation of the disease. He agrees with Axenfeld and Rupprecht that the condition is a chronic inflammation, and not a simple tissue hyperplasia. Dionin stops the violent itching, but does not cure the process. The wearing of dark glasses has the best effect.

Schmidt-Rimpler (*Klin. Monatsbl. f. Augenheil.*, June, 1908) treated a case of Frühjahr's katarrh by tying up one eye, and instilling into the other paranephrin and cocain salve. After fourteen days no greater improvement could be seen in the eye removed from the light than in the one left open. Examination of the blood showed a slight increase of the eosinophile cells and lymphocytes, but the conjunctival secretion, which was small in amount, showed neither eosinophile cells nor lymphocytosis.

Zirm (*Wchnschr. f. Therap. u. Hyg. d. Auges,* July, 1908) believes that the subjects of vernal catarrh should begin to wear dark glasses in the early spring. All irritating medicaments are to be avoided. Cold applications to the eye and cold baths of the entire body are beneficial. For local application he uses instillations of adrenalin twice daily, and employs light massage with sublimate vaselin, 1 to 5,000.

Schnaudigel (*Klin. Monats. f. Augenh.*, Nov., 1912, p. 620) cured a case of vernal conjunctivitis of several years' standing in a girl sixteen years of age, in which excision, cauterization and medicinal treatment had failed, by exposure to radium bromid 0.001 in an ebonite capsule. The sittings ranged from fifteen to thirty minutes. There has been no return since 1910. Bayer (*Klin. Monats. f. Augenh.,* Jan., 1913, p. 79; also May, 1913, p. 615) confirms the results he reported last year, that the symptoms of vernal conjunctivitis retrogress when the eye is excluded from air by a watch crystal covering. Recurrences do not take place soon after the eye has been uncovered as long as the patient remains in a dark room. The mechanical irritation excited by air currents does not suffice to produce the condition. The eosinophilia of the blood indicates only a general predisposition and is not directly connected with the clinical picture of the affection.

Bayer observed the combination of trachoma and vernal conjunc-

tivitis. The diagnosis was rendered possible through the high eosinophilia count and the large number of these bodies in the secretion.

Van Milligan, who saw much of the disease in Constantinople, advises the use of a solution of acetic acid (from 1 to 20 grains to the ounce); but this remedy is not well borne. Magnani of Turin and Gallenga of Parma use ice-cold packs, which are applied to the eyes for ten minutes at a time, five or six times a day. Danvers lays stress upon the examination of the nose and pharynx as preliminary to the ocular treatment. Darier states that in vernal conjunctivitis silver and copper are valuable only when there is an abundant stringy, muco-purulent discharge, and that the pericorneal form of the disease is to be treated by massage, with mercurial ointment made with lanolin. Davidson, Lawson, Mackay, and others have used radium with excellent results. Allport (*Ophthalmic Record*, October, 1903) has obtained good results from the Roentgen rays. If there is much pericorneal injection, atropin and amber glasses are to be used. Attention to the general health is of importance, and often a course of quinine, arsenic, or iron will be needed. Surgical treatment of vernal conjunctivitis is admissible in the tarsal type. This does not prevent relapses, and is reserved only for severe cases. The lid should be everted and the growths should be cut off with scissors. If a single tumor of the bulbar conjunctiva is present, it should be removed for diagnostic purposes (Danvers). Brossage is employed by some surgeons.—(C. P. S.)

Conjunctivitis vernalis. (L.) Spring catarrh.

Conjunctivitis with skin diseases. The relation between dermal and conjunctival diseases, although discussed under various headings in this *Encyclopedia,* is probably not, as a matter of fact, well defined by authorities. Doubtless some of the dermatic conjunctivides do not stand in the relation of cause and effect, but are accidental coincidences. However that may be, Salus (*Klin. Monatsbl. f. Augenheil.*, March, 1911) reports two cases of croupous conjunctivitis associated with or rather due to erythema exudativum multiforme. This form of conjunctival disease closely resembles and is classed with that form due to pemphigus, but differs from the membranous inflammation of the conjunctiva due to (1) bacterial infection, or (2) systemic disturbances of other types. The two cases described cleared up rapidly under mild local treatment and disappearance of the dermatologic disturbance.

A *pemphigus* of the conjunctiva associated with a pemphigus of all of the other mucous surfaces is described in detail by Bouchart (*L'Opht. Prov.*, viii, p. 161). The conjunctiva presented a hard

edema with multiple vesicle formation and many small ulcers. Although the attack resulted in almost total cicatrization, there were many recurrent attacks which were recalcitrant toward treatment. Casali (*Ann. di Ott.*, xli, p. 245) presents a very clear clinical picture of a similar case of pemphigus with an ultimate translucent thickening of the conjunctiva. Bacteriologic xerosis bacilli, streptococci and staphylococci were present, while the histologic picture showed xerotic conjunctival changes. The X-ray was used with great success in the treatment of a case of conjunctival pemphigus by Bane (*Ophth. Rec.*, xxi, p. 103). During the two years he was enabled to observe the patient, there was no return of the trouble. See, also, **Conjunctiva, Pemphigus of the.**

Del Monte (*Ann. di Ott.*, xl, p. 852, also *Arch. di Ott.*, xviii, p. 633) in six cases of *variola* found the conjunctival complications assuming four forms: (1) eruptive conjunctivitis; (2) subconjunctival ecchymoses; (3) pseudomembranous deposits upon the conjunctiva; (4) simple hyperemia of the conjunctiva.

Scrofuloderma. Three cases of this unusual conjunctival disease, each associated with fistula formation, are reported by Wätzold (*Berlin Ophth. Soc.*, Jan 25, 1912; *Ophth. Rev.*, xxxi, p. 96; *Zeit. f. Augenh.*, xxvii, p. 320). He was able to completely cure two of the three cases by surgical excision of the fistula and powdering with finely divided iodoform.

Impetigo contagiosum. The usual ocular complication of this disease is a formation of corneal pustules, but the case reported by Hansell (*Ophthalmology*, viii, p. 180) also showed a few conjunctival pustules.

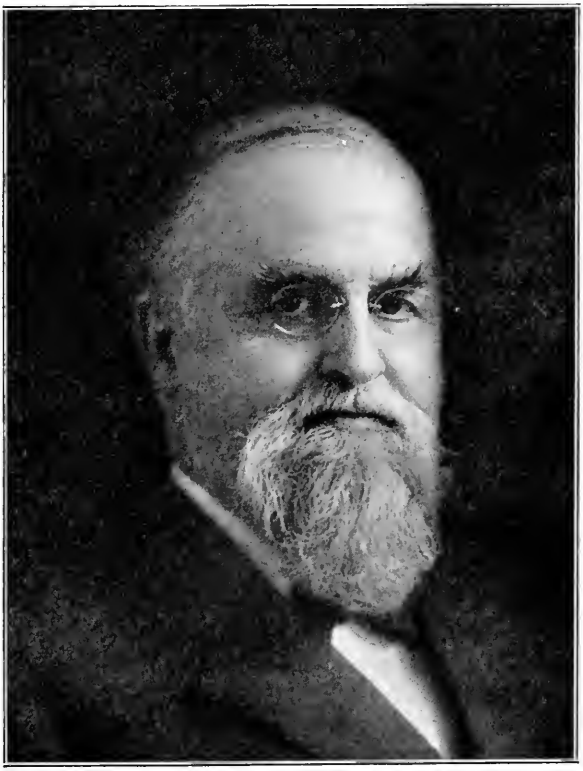
Schirmer (*Arch. of Ophth.*, xl, p. 423) reports a case of *leprosy* of the conjunctiva, following an unrecognized facial leprosy. The leprous tubercle, from which were isolated the lepra bacilli, when first seen was at the limbus and gradually advancing onto the cornea. The case, although not cured, was yielding to the X-ray. See, also, **Dermatology, Ophthalmic relations of.**

Conjunctivoplasty. A term used to designate a conjunctival flap operation for the radical treatment of corneal ulcers and wounds. See **Cornea, Ulcer of the.**

Connective-tissue ring. Scleral ring. A term applied by Loring to the faint, white stripe (best seen in the fundus oculi of elderly people) which corresponds with the rim of the scleral coat about the optic disk. It is made up chiefly of the connective-tissue elements of the inner nerve sheath; hence the name.

Connor, Leartus. A celebrated American ophthalmologist and medico-economist. He was born in Coldenham, Orange Co., New York, Jan.

21, 1843, the son of Hezekiah and Caroline (Corwin) Connor. He received his preliminary training at Wallkil Academy, Middletown, N. Y., and afterwards received from Williams College the degree of A. B. in 1865 and that of A. M. in 1868. For the next two years he was principal assistant in the Mexico Academy, at Mexico, Oswego County, New York. He then turned his attention to medicine. He



Leartus Connor.

spent one year in the Medical Department of the University of Michigan, then two years in the College of Physicians and Surgeons of the City of New York. From the latter institution he received his degree in 1870. While in New York his interest in ophthalmology and otology was awakened by Dr. C. R. Agnew and Dr. Hermann Knapp.

After a brief period of practice in Brooklyn, N. Y., and another at Seersville, in the same state, he removed to Detroit, Mich., in Feb.,

1871. At first he practised general medicine and surgery, as well as ophthalmology and otology. In 1878, however, so large had become his practice in these specialties that he abandoned the general field altogether.

Dr. Connor was a remarkably active man as a teacher, editor, society member and ophthalmologist. From 1871 till about the time of his death, he edited a medical journal which was published in Detroit and which was known, successively, as *"The Detroit Review of Medicine and Pharmacy," "The Detroit Medical Journal," "The Detroit Lancet,"* and, finally, *"The American Lancet."*

Dr. Connor was an active member of the Detroit Academy of Medicine; the Wayne County Medical Society; the Michigan State Medical Society; the American Medical Association; the Michigan Academy of Science; the American Academy of Medicine; the American Association for the Advancement of Science; the Detroit Ophthalmological Club; and the American Academy of Ophthalmology and Oto-Laryngology.

Dr. Connor was Secretary of the Detroit Academy of Medicine, 1871-72—its President, 1877-78; from 1875 to 1881 Secretary of the Faculty of the Detroit Medical College; from 1876 to 1883 Secretary of the American Medical College Association.

He was also President of the American Academy of Medicine, 1888-89; President of the American Medical Editor's Association, 1883-84; Chairman Eye Section of the American Medical Association, 1891; Vice-President American Medical Association, 1882-83; Trustee of the Journal American Medical Association, 1883-89 and 1892-94.

He it was who, beginning in 1888-89, started the movements by which the American Academy of Medicine published its own journal; established annual dues; held its meetings just before those of the American Medical Association; and began the systematic study of "Medical Sociology." From 1882 to 1889 he was a member of the Committee that founded the *Journal of the American Medical Association* and the Board of Trustees thereof after it was begun. Though the youngest member of the Board, yet, as a practical and experienced journalist, he drew up the plan of the "Journal" conduct, and carried the enterprise forward until it had become a recognized success. From 1892 to 1894 he was a member of the Committee of the American Medical Association on Revision of its Constitution, By-Laws and Code of Ethics. Dr. Connor was also the founder of the "Council of Chemistry and Pharmacy" of the American Medical Association. He was also always urging both in the state and the National organizations, the necessity for undergraduate training in refraction

work. His view was that, by a practicable readjustment of the studies in medical colleges, family physicians could care for all the eye practice now done by opticians and so give their patients the service of educated physicians.

He was President of the Michigan State Medical Society, 1902-03; Chairman of its Council, 1902-05. "During this period the profession of Michigan was reorganized and placed on a scientific basis that greatly increased its efficiency and power—a triumph of medical sociology."

Aside from his papers relating to the communal life of physicians, to the public health, and to general medicine, all of which were numerous and important, Dr. Connor wrote the following articles of special interest in our field: "*Hot Water in the Management of Eye Diseases;*" "*Optic Neuritis in Its Relations to Cerebral Tumor;*" "*Some Features of Strabismus;*" "*The Technique of Tenotomy of the Ocular Muscle;*" "*Strabismus as a Symptom;*" *Its Causes and Practical Management;*" "*The Causes of Glaucoma;*" "*Diseases of the Lachrymal Passages; Their Causes and Management;*" "*Some Sources of Failure in Treating Lachrymal Obstruction;*" "*The Giant Magnet in Ophthalmic Surgery;*" "*Does Opacity of Incipient Cataract Ever Regain Transparency?*" "*What Contribution has Vibratory Massage Made to Ophthalmology?*"

Dr. Connor was an elder in the Fort Street Presbyterian Church; a member of the Old Club; member of the Detroit Club; member of the Detroit Bankers' Club and Detroit Board of Commerce; and Director in the Home Savings Bank.

On Aug. 10, 1870, he married Anna A., eldest daughter of Rev. Chas. and Nancy (Page) Dame, of Exeter, N. H., born in Falmouth, Me., Aug. 23, 1844, and a graduate of Holyoke College, at South Hadley, Mass. Of the union were born two sons: Guy Leartus, now a well-known neurologist, born Oct. 10, 1874, and Ray, who is equally well-known in ophthalmology, born Nov. 1, 1876.

Dr. Connor was about five feet nine inches tall, of ruddy complexion, full habit, and genial and inspiring countenance. He always wore a beard, changing, however, the cut, from time to time, to accord with the prevailing fashion. His broad shoulders and massive chest did not belie his robust, vital, and energetic temperament. He was very fond of talking, and was an excellent converser. The writer recalls with pleasure the numerous inspiring conversations which he had with Dr. Connor during the intermissions at the meetings of the American Academy of Medicine. The history of the American Medical Association was one of his favorite topics at all times, and, as he

talked about this very important subject, it became as interesting as a romance. At home, he was up early and hard at work. Sometimes he drove a handsome team about the city, but, as a rule (from sheer love of the exercise) he preferred to walk. When able to leave his practice, he would wander about in the woods and botanize, "recognizing old friends and making new ones."

Dr. Connor died April 17, 1911, from a cerebral hemorrhage, coming on without warning and ending fatally in forty-eight hours.

He will be remembered long, for few have done so much for the advancement of medicine and surgery in America as did Leartus Connor.—(T. H. S.)

Cono. (It.) Conus.

Conoid of Sturm. In accounting for the form and optical relations of the astigmatic pencil, we find that when the latter is the result of refraction by a sphero-cylinder circles of diffusion are formed and among them we see geometric forms that include two straight or *focal lines.* Together the rays no longer form a cone in which all the rays pass through a point, but we have to deal with a more complicated system, characterized by this peculiarity, that all the rays pass through two short straight lines perpendicular to each other. The system is known as the conoid of Sturm.

Cono-myoidin. Conomyoid. Stort discovered that the change in position of the retinal pigment, or the shifting of the retinal cones under the influence of light in frogs and other animals, is due to the protoplasmic portion of the inner limb, which Engelmann called cono-myoid. This substance expands in darkness and contracts in light. A recent paper on this interesting subject is by H. Fujita (*Archiv f. vergleich. Augenheilk.*, p. 164, 1911). It is reviewed in the *Ophthalmoscope*, 1911, p, 792, under the caption, "Pigment Movements and Cone Contraction in the Darkened Eyes of Frogs."

Conoscope. A form of polariscope for the observation of crystalline sections.

Conrad's water. An eye-wash composed of three parts of mercuric chloroid, 100 of distilled water, and five to ten of tinctura opii crocata.

Consanguinity in ophthalmology. Although it was at one time believed that the marriage of persons closely related by blood is productive of definite diseases of the eye (especially *retinitis pigmentosa* and the *amaurosis of family idiocy*), yet this contention is not now strongly held. For example, although Stilling believed that consanguinity is a distinct factor in producing the most marked forms of myopia, yet Velhagen, who investigated 50 high myopes whose

punctum remotum was at 11 cm. or less, found only one case with consanguinity, though he did not choose the specially deleterious forms. Wolff found 8.75 per cent. of 126 high myopes with fundus changes in which consanguinity could be demonstrated, whereas Otto failed to find this factor in the rich material afforded by the Leipzig clinic.

According to Minis Hayes (*System of Diseases of the Eye,* Vol. 2, p. 441), from a careful investigation of this subject (reinforced by the labors in the same direction of G. Darwin, Huth, Lanery, Fieuzal, and Ferret) Trousseau (*Hygiene de l'Oeil,* p. 139) reached the conclusion that, independent of heredity, *consanguinity* does not play any role in the production of blindness. Taking congenital cataract, retinitis pigmentosa, and albinism as types of the affections to which there has been a marked tendency to ascribe consanguineous origin, Trousseau has given them a careful study. He finds that of twenty cases of congenital cataract, in eleven neither heredity nor consanguinity existed. In five heredity was manifest; in three consanguinity appeared, at first, to play the principal causative part, but further investigation soon showed that heredity was a preponderating factor. In one case the investigation was insufficient. In eleven cases of retinitis pigmentosa, four were without evident cause, five were hereditary, and two were apparently of consanguineous origin, but closer investigation showed them to be clearly hereditary. Of three cases of albinism, one was of obscure origin, one was hereditary, and one was apparently consanguineous but was in reality of hereditary origin. As the result of his investigations, Trousseau holds that, without the intervention of heredity, consanguinity is powerless to produce ocular lesions. It cannot cause any morbid state without the materials which heredity furnishes to it, and hence, from the hygienic point of view, there is no good reason to interdict consanguineous marriages when the visual organs of the contracting parties are sound and well formed. Magnus, too, holds that we have no proof of the influence of consanguinity in causing blindness.

On the other hand, a study of the reports of Nettleship, Bemis, Snell, Schneider, Leber and Ayes, as well as the U. S. Census reports and those of France, is regarded by W. C. Posey and A. Saulter (*Ophthal. Record,* Dec., 1910, p. 682) as convincing evidence that *consanguineous marriages are productive of a high percentage of blindness* and other serious defects of the offspring.

They find from the last census of the United States that of the 56,507 blind, 4.5 per cent. were the issue of the marriage of cousins.

The danger of blindness to the offspring of such marriages seems to be four and one-half times greater than to children whose parents are not related. Upon such ground they would have every practitioner of medicine answer the question, "Is the marriage of cousins justifiable?" by an emphatic "No."

Dudley (*Arch. f. Ophth.,* September, 1909) reports a family, including 47 individuals, of whom 26 had nystagmus, in which the influence of consanguineous marriages in perpetuating the defect was rather strikingly illustrated. Libby (*Denver Med. Times,* September, 1909) reviews the influence of consanguinity in the production of eye defects and degenerative diseases in general, especially in the case of familial cataract and retinitis pigmentosa.

As a further contribution to this vexed question, Zahn and Laquer have noticed consanguinity of parents as a cause of infantile glaucoma. Zahn estimates that 10 per cent. of the cases of buphthalmia are the result of consanguineous marriages. See, also, **Heredity.**

Conscious vision. Consciousness of the visual act. That an animal *may know that he sees* or that he is conscious of visualization, it is probably necessary that the brain should be intact, although experiments by Goltz have thrown some doubt upon that proposition. The whole subject of the relation of consciousness to vision has been discussed in an address by M. Straub, Rector magnificus of the University of Amsterdam and Professor of Ophthalmology. A review of this paper by A. Levy (*Ophthalmic Review,* May, 1912, p. 147) is given in its entirety, as a good exposition of a rather abstruse subject.

The first theory of vision was that of Kepler, who in 1611 published his work in which he regarded the eye as a physical instrument which formed a picture of visible objects. Thus he regarded vision as the sensation conveyed to the brain from a stimulated nerve epithelium. And this theory has even been followed in modern times by Hering and his school, who sought to find in the anatomical structure of the eye the conducting paths and the brain cortex an explanation of all the phenomena of vision. In fact Nuel, one of this school, writes: "We do not know if anyone sees—all we know is if an action follows on light stimulus. Therefore it is better to speak of photo-reaction than of vision."

Against this extreme mechanical view Helmholtz led the way in that he employed psychological terms in his explanation of the visual function—and however much may be explained on purely mechanical and anatomical grounds, there always remains something which this does not explain, and while anatomy shows us how the

visual stimulus can reach the occipital cortex, it does not explain how we become conscious of this stimulus.

When the eye is stimulated we are conscious of a source of light of a definite color, in a definite direction and at a definite distance, and these three fundamental conceptions must be considered. Color is for the time being left out and direction is considered.

Our eyes are capable of being directed in a very great number of directions, and we always combine a sensation of light with a sensation of direction. It is obvious that the rods and cones are the material representatives of direction, and it is their difference which enables us to form this judgment. Bishop Berkeley stated that we know of direction by means of "experience," and Helmholtz following this has used the term vision. And clinical experience has shown this to be correct. Since Cheselden in the 18th century published his case, there have been many cases recorded of persons born blind who later in life obtained the power of vision, and in all these cases the faculty of seeing was by itself of no use until after months the necessary experience was acquired to enable them to interpret their visual sensations. Stratton in 1896 made an experiment on himself. He bound up one eye and before the other wore an inverting telescope so that the images on the retina were erect, and of course everything looked upside down. For the first two or three days he could do nothing but had to be led about like a blind person. By the fourth day he was able to perform a few simple acts after careful and anxious consideration. By the end of a week he was able to carry out all the ordinary movements quickly and satisfactorily if he did not think about them, but if he thought about it, it at once became very awkward—but everything appeared upright to him. This experiment proves conclusively that absolute localization of direction is the result of experience. Once we have acquired the faculty of differentiating direction we are able to appreciate movement. When an object crosses successively many lines of direction we assume it is moving unless we ourselves are conscious of a movement of our bodies or eyes, in which case the conclusion we arrive at is a judgment based upon the consideration of two or more factors. When we are moved as in a railway train a third phenomenon comes into consideration, namely, parallax, and this is always used in the judgment of distances. Parallax plays an extremely important rôle in vision, although for the most part we are unconscious of it. Its absence at times when expected leads us to false conclusions, as the apparent turning of the face in a picture when we walk by.

The next thing considered is distance, and the correct judgment of distance is closely associated with binocular vision, and also vision in three dimensions, stereoscopy, is very closely associated with binocular vision—in fact some confusion has arisen by mistaking one for the other. Wheatstone was the first who showed how stereoscopic vision is produced, and it was assumed that binocular vision was essential to this, forgetting the effect of parallax. For obviously one-eyed people manage to get about quite as well as two-eyed people, and they must be able to judge distances and solidity in order to do this. We combine ordinarily two different pictures of an object in one solid whole. If these two different pictures are received in rapid succession in one eye, it is possible for our consciousness to construct a picture in three dimensions out of this as well.

For very distant objects the distance between the two eyes is negligible and parallax alone gives us the information—so for near objects parallax must play a very important rôle in our judgment of distance and solidity.

The conclusion therefore is that in addition to anatomical structure and hereditary tendencies the most important element in the consciousness of vision is experience.

Consecutive images. Images following each other in regular order.

Consensual light-reflex of pupil. Indirect light-pupil-reflex. The contraction of the pupil to light may occur indirectly because of the stimulus that is given only to the *opposite* eye; and this either by reason of the decussation of the fibers in the chiasma or because of its transference from one nucleus to the other.

Consensus oculorum. (L.) An obsolete term for the intimate association between the two eyes, as in vision, in the action of the various ocular muscles and in various diseases.

Conservation of energy. The preservation of energy by the transmutation of one form into another, as from friction to heat, to light, or to electricity, by means of which the total sum of energy is maintained invariable.

Conservation of vision. Popular hygiene of the eye. This subject is not only of prime and practical interest to such specialists as ophthalmologists, school officials, school architects, and illuminating engineers, but it is of the utmost importance to the public at large. Some of its varied aspects have already been considered in this *Encyclopedia* under several headings, notably, **Blindness, Prevention of.** Several important parts of the subject will also be discussed in this and other volumes.

Daily care of the eyes from infancy to old age. Infants' and children's eyes should never be exposed, even in sleep, to the glare of strong light, artificial or natural, and this is particularly imperative when the child is taken out in a perambulator or carriage. The eyes should then be protected by an awning or parasol lined with material that will not reflect the sun's rays upon the face.

They should not be encouraged to use their tender eyes for near work and their playthings ought to be large objects, easily seen. Kindergarten and primary schools should recognize this rule, so that the occupations of the child do not injure the eyesight. No fine, difficult, or prolonged visual labor should be permitted lest present eye-strain be produced or a foundation for later myopia be laid. Sewing, map-making, perforated card problems, much reading, intricate drawing, *et hoc genus omne,* should be banished from every primary school. As Pyle properly observes: "If a child has red eyes, holds its book close, complains of not being able to see at a distance, looks at objects sideways or between partially-closed lids, or squints or complains of headache, browache, or pain in the eyes, it is the parents' or teachers' duty to send it to a competent oculist. If the oculist decides that glasses are necessary, they should be put on at once in spite of any foolish prejudices, for they will surely promote the physical and intellectual development of the child and prevent many years of suffering and perhaps irreparable ocular disease."

The age at which a child should be sent to school depends largely upon the condition of his visual apparatus. If he has no ocular defects, is otherwise in good health, and is never "crammed," or made to study out of school hours, half a day's schooling may be commenced at seven or eight years of age by the average child. The amount of work may be gradually increased until at ten he does a full day's work.

Children in poor health, especially if they exhibit ocular or aural defects or show a tendency to myopia, or present evidences of eye-strain, should have little or no systematic schooling before they are twelve years old. That child will be happier and a better citizen, as well as a more successful man of affairs, who develops into a fairly healthy, though imperfectly schooled, animal at twenty than if he becomes a learned, neurasthenic asthenope at the same age.

School books should be easily read and small enough to be readily handled. For ocular reasons they should not contain smaller type than "10 point" (long primer). The lines should be at least one-tenth of an inch apart. (Note examples of spacing subjoined.)

TYPE PROPERLY AND IMPROPERLY SPACED.

The conjunctival vessels on the globe are in most cases enlarged, but, in the milder types, there is no marked redness of the ocular conjunctiva, the thickening and redness being confined to the conjunctiva of the lids, particularly at the junction of the lids and the eyeball in the retrotarsal folds.	The conjunctival vessels on the globe are in most cases enlarged, but, in the milder types, there is no marked redness of the ocular conjunctiva, the thickening and redness being confined to the conjunctiva of the lids, particularly at the junction of the lids and the eyeball in the retrotarsal folds. Sometimes there is a slight chemosis present
Properly Spaced.	Improperly Spaced.

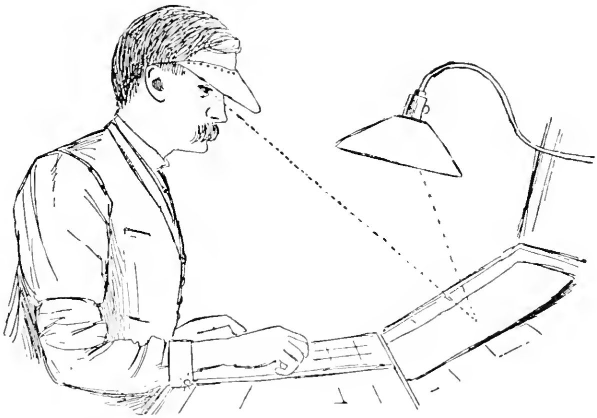
[The printed text of this book is an example of proper spacing.]

They should not contain more than 60 letters nor be more than 4½ inches long, so as not to fatigue the muscles in consequence of undue rotation of the eyeballs. The paper used in books and magazines should not be, as it often is, so highly glazed that it acts as a mirror to reflect the light into the eyes. It is not always possible to accomplish this where "half tone" illustrations are frequently used with the text. In this book, for instance, a compromise has been effected by the employment of a partially glazed, opaque paper. The type should be distinct and the printing well done. Bad paper, poor ink and worse printing are too frequently encountered in our books and newspapers.

In adult life the hygiene of near work is also of prime importance. The enormous increase during the past twenty years in the amount and variety of work, which the full-grown man and woman expect from the eyes, is largely responsible not only for the added need of glasses, but for the great increase in the direct and reflex results of eye-strain. If we expect to have comfort and to use our eyes to their fullest capacity we must select reading matter in large type, correctly spaced, printed with good ink in short columns, on unglazed paper. Other precautions are necessary, especially if the eyes are used constantly, as in the case of students, clerks, typewriters, book-keepers, cashiers, sewing girls, etc. The reader or writer should sit upright and a little forward; the book, paper or other form of near work (a heavy volume may be placed on an adjustable book-rest so that the top and bottom of the page are the same distance from the nose) must not be nearer than 12 inches nor more than 20 inches distant. The

illumination should be from over the left shoulder or to the left and above the head. If it is impossible to have a proper arrangement of the light, the latter, if an electric or other form of lamp, should be covered so that sufficient light is thrown upon the work to be done, and an eye-shade ought to be worn by the worker.

Injurious reading habits. Long-continued reading while lying down (especially in bed when convalescent from an acute disease), in



Improper Illumination.

a railway train, on street cars, out-of-doors (by direct sunlight), by firelight, when tired or sleepy or when the eyes are fatigued or strained, is distinctly injurious. Fine sewing, embroidery, china-painting, drawing, engraving, working on black goods and similar tasks should be performed only in the daytime by persons possessed of the strongest eyes and best health. Such work should also be interrupted with sufficient frequency. The habit of wearing dotted or figured veils is responsible for a good deal of eye-strain. When they are used for protecting the face and keeping the hair smooth, or keeping the headgear in position, they should be thin, with a large, uniform mesh.

In the remainder of this article there will be considered chiefly those subjects that have been discussed by the contributors to the Conservation of Vision Series—pamphlets prepared by a Committee of the Council of Health and Public Instruction of the American Medical Association. To the authors of these pamphlets the writer is greatly indebted for much of the following matter. Their names and

the titles of the monographs are as follows: *Schoolchildren's Eyes,* by Dr. Frank Allport, Chicago, Ill. *Industrial and Household Accidents to the Eye,* by Dr. Harold Gifford, Omaha, Nebr. *Wearing Glasses,* by Dr. W. B. Lancaster, Boston, Mass. *The Relation of Illumination to Visual Efficiency,* by Dr. Ellice M. Alger, New York. *Trachoma in Eastern Kentucky,* by Dr. J. A. Stucky, Lexington, Ky. *Auto-Intoxication and the Eye,* by Dr. H. D. Bruns, New Orleans, La. *Eye-Strain,* by Dr. Hiram Woods, Baltimore, Md. *Lenses and Refraction,* by Dr. Frank Allport, Chicago, Ill. *The Eye and Its Functions,* by Dr. Frank Allport, Chicago, Ill. *Care of the Eyes,* by Dr. Frank Allport, Chicago, Ill. *Infant Blindness, or Ophthalmia Neonatorum,* by Dr. F. Park Lewis, Buffalo, New York. *Ordinary Eye Diseases,* by Dr. L. W. Dean, Iowa City, Iowa. *Usual and Unusual Eye Accidents,* by Dr. E. C. Ellett, Memphis, Tenn. *The Eyes of Transportation Employees,* by Dr. J. J. Carroll, Baltimore, Md. *Ocular Hygiene in Schools,* by Dr. S. D. Risley, Philadelphia, Pa. *Whisky, Tobacco, Drugs and the Eye,* by Dr. Edward Jackson, Denver, Colo. *Preparation for Blindness,* by Dr. F. Park Lewis, Buffalo, N. Y. *What to Do For Blind Children,* by Dr. F. Park Lewis, Buffalo, N. Y. *Blindness from Wood Alcohol,* by Dr. Casey Wood, Chicago, Ill.

In this section the various subjects are presented in as simple and direct manner as possible, the intention being to afford an opportunity to ophthalmologists and others to make use of the material (including the illustrations) for popular lectures and contributions to lay periodicals rather than to furnish purely scientific facts to a restricted clientele. Most of the latter will be found elsewhere, especially under the heading **Blindness, Prevention of.**

The condition involving the question of visual conservation which first, in point of age, attracts the attention will be found in efforts to prevent that dreadful ocular disease that develops in the first few days of human life. It is known as *ophthalmia neonatorum* or the conjunctivitis of the new-born child.

In considering this disease and its prevention nothing could more clearly set forth the subject in its most modern sense than the views of F. Park Lewis, Buffalo, New York, who has probably given this topic as much careful consideration as any one in the United States.

Those who have visited a school for the blind have been impressed by the large number of pathetic little figures, groping their way in the bright daylight, who have been left with eyes that are not only sightless, but which are also deformed, disfiguring, protruding and repellent. A great many of these cases are the result of an inflammation occurring during the first weeks of life, due to an infection which

enters the eyes of the baby at or shortly after birth. As this is a disease which can almost always be avoided and as any child exposed to it is likely to become blind, it is of first importance that everyone should know from what it comes, what must be done, and what must not be done, in order that babies may be saved from the calamity of blindness.

In the first place, it is necessary to understand something of the nature of infectious diseases. Just as plants grow in the earth, live for a certain length of time, produce their fruit and then die, leaving their seeds to produce new plants, so in the vegetable world a low but exceedingly varied form of life passes through similar processes within or on living plants and animals. These little plants are so small that they can be studied and their development followed only by examining them through microscopes of high power. It is then found that these tiny structures multiply with great rapidity, when they are placed under conditions suitable for their growth, and in the process of growing, destroy the tissues in which they develop. It has been one of the discoveries of modern science that almost every contagious disease is caused by a special minute germ. If material containing these germs is not brought in contact with the tissues on which they grow, there is no danger of infection resulting from them.

The human body is lined with a soft, moist, warm membrane on which these organisms grow with great readiness. This membrane is found within the eyelids and on the eyeballs. Quite a large number of different germs produce results that appear to be alike. Some one or more of the different varieties of germs in their development cause yellow, mattery discharges from the body. If this matter, or pus, as it is called, is carried from the membrane of one person to that of another, as that within the eyes, it sets up a similar inflammation with the same kind of discharge. One of the most dangerous of these infecting organisms is that which comes from impure sex relations. The pus discharge which it causes is exceedingly difficult to cure. Frequently months and even years after it is supposed to be cured the infecting germ is still left in the tissues.

A young man, having "sown his wild oats" and thereby having acquired this disease, marries, and, if he has not had a perfect cure effected when such a condition existed—and it is quite possible with care to have it cured—he is in great danger of infecting his wife. This may not produce very noticable symptoms in her at first. The germs often lie dormant until her baby comes, and then during the birth of the child they may be carried with the fluids of the body into the child's eyes. If uncared for or improperly treated, the resulting inflammation may cause blindness.

No man then, who has suffered from gonorrhea, as this discharge is called, has a moral, and he should have no legal, right to marry until he knows as the result of an expert examination that he is no longer the bearer of an infection which can produce such terrible results. The seriousness of this disease can hardly be over-estimated, and it should never be regarded as a light or trifling ailment.

While gonorrhea is the original cause of a very large proportion of the birth-infections of the eyes of babies, it must not be assumed when such a condition arises that it necessarily has this origin.

There are a number of other organisms which produce discharges of yellow matter from the eyes when infection has occurred, such as the germs which cause pneumonia and those of diphtheria, as well as others which are less well known to the public generally. The effect of some of these infections is equally severe and equally disastrous as that which comes from the gonococcus, as the little organism which produces gonorrhea is called. Most of these infections, however, are not dangerous to the sight and are readily controlled, but it is impossible to determine which are the serious ones without having an examination of the discharge made by one who is expert. It is safer always to assume that an infection of this character is of a serious nature and one requiring prompt, intelligent and skillful treatment. The greatest danger is from the neglect of seemingly simple infections of the eyes. The midwife is not experienced in the nature of inflammation of this kind, and sometimes even the doctor, however well trained he may be in general diseases, fails to understand the rapidity with which injury is done to the delicate structures of the eyes, which no subsequent treatment can repair.

Something more than a quarter of a century ago, the celebrated Belgian surgeon, Credé, feeling, as did the doctors all over the world, the dreadfulness of having babies go blind from a condition which might be prevented, instituted a series of careful investigations as to measures which might be employed for the destruction of these little germs after they had gotten into the babies' eyes and before the important structures had been destroyed. His experiments extended over many months. Finally, his efforts were rewarded. He found that an inexpensive solution of nitrate of silver, prepared with great care and used in a very definite way, could be employed in very small quantities in the eyes of every new-born baby without hurting the eyes of the child, but so destroying the vitality of infecting germs that might have found lodgment there that they failed to develop and no infection followed. By proper care of the new-born child, and by the use of protecting drops in the baby's eyes, imme-

diately after birth, in almost every instance infection can be prevented; and by the use of the prompt, intelligent and skillful care of an oculist, even when such an inflammation does develop, it can be cured and the sight of the child saved.

In every case in which the eyesight is lost, the doctor or the midwife is no doubt very sorry and feels that if he had only known he might have cared for the child in a different way. Sometimes, unfortunately, the doctor or the midwife, through a lack of knowledge as to the real conditions, feels that he knows how to treat those cases as well as any one else and when the child becomes blind, with the same fatalistic feeling that the Arab has, he thinks that it was the will of God and that nothing could have saved the baby's eyes. Had the child been in his own family possibly the matter would not have been passed over so readily, because we are all given the grace to bear others' misfortunes. But when we think of the long life of darkness of the blind, the limited possibilities of the child to be educated, the narrow lines in which he may hope to be trained, the fields of usefulness from which he will be cut off by his blindness, his dependence on others for things that he should otherwise do for himself, and the financial cost to the community for his maintenance when he might under happier conditions not only have been self-supporting but possibly independent, the pity of it all comes with added emphasis. The importance then increases of every intelligent human being knowing that the most serious forms of birth-infection of the eyes in almost every instance should not have occurred.

How to avoid infection. It is evident that if babies are to be prevented from becoming blind, the danger of infection must be recognized by the father and mother long before the baby comes. When there is any likelihood of an infection being present, the mother should be examined by a competent doctor. Since these subjects are receiving so much attention by health boards, there ought to be no difficulty in finding a physician capable of making the necessary examination with the microscope at the proper time. If an examination shows that an infection is present, the mother should be thoroughly treated until it has disappeared. While this is a matter directly pertaining to physicians, the importance of knowing that there is no infection present is so great to the father and mother of the expected child that they should never be satisfied until they know that this source of danger has been eliminated.

The first imperative requisite is a recognition of the fact long before the birth of the baby that the mother is in condition to convey an infection to the eyes of her child.

As J. Clifton Edgar says: Inflammation of the eyes of the new-born in a mild degree may follow the use of the drops which have been used in childbirth to prevent infection. This tends to subside properly without causing changes in the tissues; and were it not for the fact that many of the serious cases begin in the same way it would be of relatively little importance.

Purulent ophthalmia of the new-born must be considered from several standpoints: From what source does the infection arise, what are the possibilities of eliminating the sources of infection, and what is the preventive treatment.

The birth of the child through the maternal passages causes it to come in contact with the mother's secretions. If the mother has been infected with gonorrhea, the eyes of the child are apt to be infected during the process of birth. Carrying the infection from fingers or discharges during the period after birth is of frequent occurrence. This is not at all surprising when the many opportunities are considered.

Another method by which this infection occurs is by the contamination of one child from the secretions from the eyes or from the discharge of other infected infants. This mode of infection is particularly common in institutions, and undoubtedly the direct means of infection is not so often the fingers of the nurse as from the all too prevalent method of transporting the babies from the nursery to the wards in trucks or carriages in which they lie in close contact with one another. The disease may also occur from contamination from the infected person of a physician, midwife, infant's nurse or wet-nurse, although it is probable that very few cases occur in this way.

Edgar further asks: What are the possibilities of eliminating the sources of infection? He answers:—The care of the mother before confinement should receive more attention than it does at present. The history of every pregnant woman should be thoroughly investigated for symptoms of gonorrhea occurring not only during but also previous to her pregnancy. This may be done without arousing the patient's suspicions as to the reason for the questions. A history of frequent and burning urination, followed by an increase in the amount of vaginal discharge, is a warning that is like a red flag of danger. A woman with such a history should have the most painstaking laboratory investigation of her secretions made.

Every woman, no matter what her station in life or how free her history is from symptoms of inflammation, should have early in her last month of pregnancy a laboratory examination of her private secretions made.

Edgar's second question is: What is the best way to prevent this disease? A. Treatment during labor. He answers in his own words: Perhaps the most important thing that the obstetrician has to do as the head reaches the lower opening is to prevent a tearing of the tissues. With his or her aim devoted to this object, the feeling of satisfaction or relief occurring when this is successfully accomplished tends to cause a relaxation of his care and the desire for the birth of the remainder of the child is only equaled by that of the patient herself.

At this point in the progress of labor there is a natural or normal wait. The head is born and the pains cease for a moment. During this stage of inaction the obstetrician has an opportunity to do a simple little act, but perhaps no movement of his during the entire progress of labor is fraught with such importance. He wipes the secretions from the eyes of the partially-born child and then irrigates them by squeezing over them a gauze sponge saturated with boric acid solution. He may then turn to the delivery of the shoulders and by that time the contractions of the womb will have returned and the shoulders will have turned and may be delivered.

In the case of known infection of the mother, the obstetrician is justified in shortening the second stage of labor by the application of forceps. This shortens the period that the eyes of the child are in contact with the infectious material.

B. Treatment after delivery. As soon as the cord is tied and it is seen that the mother is in no danger, the child is placed on its side and the lower eye is exposed by retracting the lids. The conjunctival sac is then washed out with a saturated solution of boric acid and two drops of 1 per cent. solution of silver nitrate are dropped into the eye. This proceeding is repeated on the opposite side, first turning the child on that side. It is of first importance that this solution be left in the eyes and not washed out at once. The drug is put into the eyes for the purpose of destroying the organisms there present and it can not accomplish this object instantaneously.

If the infant has a discharge from its eyes after the use of the silver nitrate, it may be due to the chemical irritation, but if such a condition occurs the discharge is usually not matter and promptly subsides. Nevertheless, every discharging eye should be made the subject of a microscopic investigation for the presence of gonococci, the pus germs of gonorrhea.

In the case of infection with the gonococci the treatment should be placed in the hands of a competent oculist, but in general the plan of treatment consists in keeping the eye clean by constant or nearly constant irrigation with salt solution or boric acid; by preventing

adhesions of the iris by atropin, and by instillation of 1 per cent. silver nitrate twice a day.

The child's first bath. The child's first bath is of the utmost importance. The eyelids must first be very gently wiped free from the mucus and other matter covering them, a piece of absorbent cotton dipped in boric acid solution serving very well for this purpose. The head must then be cared for, a soft wash cloth being employed and wrung almost dry from warm water. Under no circumstances must water be poured over the head so that the secretions could in that way be washed into the eyes. When the general bath is given the water that is used for the bath must never be used about the head. An obstetrician of wide practice spoke at a medical meeting of deluging the head of the child with water, failing to recognize the danger to the child's eyes in the procedure. Indeed, this water of the bath has been called by the Germans "Gift-wasser" or "poison water," so dangerous an element is it in this connection.

Unless the family in which a case of ophthalmia neonatorum occurs is sufficiently well to do to secure the services of two nurses, it is always better that the child suffering from this disease should be treated in a hospital. As a large proportion of these cases occur in the families of the poor, provision should be made in every city for the immediate transportation of the mother and infant child to the nearest hospital. This is not always an easy matter, especially if previous arrangements have not been made to meet such emergencies. A baby having an infective discharge requiring isolation from other children and demanding the unremitting care of two nurses continuously is a very heavy tax on the resources of any hospital. From a purely business point of view, such cases are considered most undesirable. Not infrequently the mother of the child herself is unreasonable and unwilling either to go to the hospital or to stay there after having been sent. She has no idea of the danger to her child, and even if it is explained to her there are few that have sufficient imagination to realize in advance in anything like its completeness the meaning of blindness in babyhood as influencing the entire life of a human being. It is not enough, therefore, that in a case of this kind the mother be asked or even urged to place her child under proper conditions for its treatment. The department of public health, in conjunction with those associations devoted to caring for the welfare of children, should insist on it that the child be protected, if necessary, even from its ignorant parents. A few days of neglect may result in a lifetime of misery. The relatively small amount needed to protect the child from such a fate ought not

to be considered for a moment when placed in the balance with the result. The imperative necessity, therefore, on the part of the health authorities of securing for such infected children the necessary and adequate care, cannot be overstated, but in order that they may protect the child they must first know that a child has been born and that an infection has occurred.

Ophthalmia neonatorum should be reported. We are only beginning to realize our deficiencies in the reporting of births throughout the United States. Happily this is being corrected, but there is by no means as yet a sufficiently general adoption of the requirements for reporting to health boards the existence of each case of ophthalmia neonatorum. The existence of each case of infection in the new-born, no matter what the origin, should be promptly brought to the notice of the department of public health.

During the past few years agitation regarding ophthalmia neonatorum has been so widespread that in almost every state there has been a large number of popular addresses on this subject. Six states and many cities are now distributing proper remedies for its prevention. In New York State, during the past year, 18,811 outfits, containing a 1 per cent. solution of nitrate of silver, with a circular in English, Italian and Polish, were sent through the 1,600 health officers to both midwives and physicians. The seriousness of birth infections is now so much more widely appreciated that the proportion of babies becoming blind from this cause is diminishing. But human nature is always the same, and no matter how complete may be the actual knowledge of both midwife and physician on the possibility of infection of the eyes at birth, there will always be those who are negligent and careless. It becomes increasingly evident that unless stringent regulations are made and enforced children will be allowed to become blind whose eyes could have been saved.

Birth blindness can be, and is being, stopped. Henry J. Wilson, secretary of Gardner's Trust for the Blind, says in the *London Chronicle* that the amount of blindness all over the world is gradually decreasing, and one of the most important agents in this beneficent result he considers to be the making of ophthalmia neonatorum a compulsory notifiable disease.

The Committee on the Prevention of Ophthalmia Neonatorum of the American Medical Association, after extensive inquiries in this country, found the following proportion of cases of blindness resulting from ophthalmia neonatorum as shown by the records of the various schools for the blind:

REPORT OF SCHOOLS FOR THE BLIND, 1907

	No. of new admissions	No. blind from ophthalmia neonatorum	Per cent.
New York State School for the Blind.......	13	4	30.7
Pennsylvania Institute for the Blind, Overbrook, Pa...........................	27	9	33.33
Institute for the Blind, Austin, Texas.......	*	*	
Perkins Institute and Massachusetts School for the Blind.........................	43	13	30.00
Colorado School for the Blind, Colorado Springs	7	3	42.8
Western Pennsylvania Institute for Blind, Pittsburgh, Pa......................	28	8	28.57
(Percentage of total number in school, 31.37.)			
Missouri School for the Blind, St. Louis....	19	6	31.57
State Board of Education for the Blind, Hartford, Conn.....................	8	1	12.50
(Since creation of Board in 1893, 34.74.)			
State School for the Blind, Columbus, Ohio..	61	6	9.83
(Reduction of usual percentage and as low as at any time in last twelve years.)			
Maryland School for the Blind.............	13	4	30.77
(Percentage of total number in school in 1905, 25.50.)			
Ontario Institute for Blind, Brantford, Ontario	23	5	21.74
(Percentage of total number in school, 24.7.)			

The average, then, of the new admissions in the fall of 1907 to the ten schools in which exact records were kept and representing eight states and the province of Ontario, was 25.21 per cent., or one quarter of the whole number, needlessly blind.

* Not definite; about 40.

That these are not unusual results is shown by the following report from the Pennsylvania School for the Blind for the past eight years:

	Per cent.		Per cent.
1900............	11 out of 25—44	1904............	15 out of 56—25
1901............	10 out of 26—35	1905............	21 out of 42—50
1902............	9 out of 39—23	1906............	12 out of 38—31
1903............	14 out of 50—28	1907............	9 out of 27—33.33

The average percentage of these eight years is 33.36 per cent. of the whole number admitted. As this enormously high proportion of blindness due to ophthalmia neonatorum is found in states maintaining the highest standards of medical education and general sanitation, there is no doubt whatever that when exact statistics can be obtained at least as large a percentage due to this cause will be found elsewhere throughout the country.

The cost of ophthalmia neonatorum. The economic loss to the nation through the preventable blindness due to this cause is enormous. A child who is blind is usually not only educated at state expense, but is cared for in a special institution in which he also receives his maintenance. The average cost for the education of a normal child in the public schools is about $30 each. The cost per pupil in the State

School for the Blind in Ohio is \$340, or over ten times as much as it costs to educate a normal child. In the State School for the Blind at Columbus there are seventy-four victims of ophthalmia neonatorum. The excess cost for the maintenance of each one of these over what it would have cost had their sight been retained was \$310. The total annual excess for the maintenance and education of those children made blind from a preventable cause was \$25,160. An equal proportion has existed throughout the United States. Howe has estimated that "the probable annual cost to the State of New York for the support of the victims of ophthalmia neonatorum is over \$110,000." It would seem that there is probably no more unwarranted as well as pathetic extravagance on the part of the state than that which comes from its negligence in properly protecting its children from this controllable and preventable disease.

A full discussion of this all-important subject is published in the *Ophthalmic Year-Book,* page 114, 1909. Among other remarks the reviewer notices Ernest Thomson's British work on ophthalmia neonatorum, in which he makes himself largely indebted to Sydney Stephenson. This does not lend itself readily to an abstract, but from it certain interesting statements may be quoted. In making reference to the nature of the infection, he records a sentence from a lecture by Horrocks, in which that author says: "If none of these things, that is, distinct evidences of infection, are found, then it is to be assumed that the mother is healthy and the child's eyes are to be left alone accordingly." He very properly adds that such teaching is misleading, since it tends to minimize the importance of latent gonorrhea, because, as Stephenson has shown, most of the cases of acute ophthalmia originate from a latent or residual gonorrhea in the mothers.

Thomson points out that, apart from exceptions, ophthalmia occurs in two forms, a severe and a mild, and that the first is usually due to the gonococcus, and the second usually to other micro-organisms. In an analysis of 1,829 cases of ophthalmia neonatorum, Stephenson found that 64.56 per cent. were due to the gonococcus.

Stephen Mayou, in an examination of 40 cases, found 57.5 per cent. to be due to the gonococcus, while among 1,483 cases comprising his own series and those of other observers, he found that the gonococcus was present in 63.5 per cent.

Elschnig found 21 non-gonorrheal forms out of 41 cases of blennorrhea neonatorum (in Vienna). The organisms encountered in these cases were streptococcus pyogenes, bacillus pyocyaneus, staphylococcus albus, aureus and citreus, diplococcus pneumoniæ, and three

times xerosis bacilli in large numbers. The gonorrheal cases appeared almost exclusively within the first three days; the non-gonorrheal cases after the fifth to the seventh day.

For *prophylaxis* Greeff believes that one-fourth per cent. solutions of nitrate of silver are strong enough. At the Charité, Berlin, irrigations of one-tenth per cent. solutions of nitrate of silver are used every one to two hours during the first few days, the lids not being everted but repeatedly opened and closed while the solution is being dropped into the eye. Pinard reports that since he has employed the Credé method he has reduced ophthalmia neonatorum in his service by 30 per cent. He instils one drop of a 2 per cent. solution of silver nitrate into each eye, immediately after birth. In over 10,000 cases he has never observed any bad results from this method.

Stephen Mayou has written an admirable article on all of the phases of ophthalmia neonatorum, and by an elaborate investigation has found that in England and Wales there are 2,965 children under fifteen years of age who have become blind from this affection. Moreover, .161 per cent. of all cases attending the Moorfields Hospital and the Central London Ophthalmic Hospital have suffered from this disease, while 27 per cent. of the inmates in the various blind schools in England have definitely lost their sight from ophthalmia neonatorum. According to data which he has obtained from lying-in institutions of the United Kingdom, ophthalmia neonatorum furnishes a percentage which varies from .02 to 1. In one of these institutions protargol and nitrate of silver were used as prophylactic agents. All others depended upon bichloride solution or nitrate of silver, or both. Since the introduction of this prophylaxis there has been a great decrease in the development of ophthalmia neonatorum, but it is still prevalent to an unnecessary degree, and the percentage could be still further reduced by the universal use of prophylaxis and notification of the disease as it occurs, together with proper instructions to be given to midwives and students. Franz also calls attention to the importance of the subject.

Hellendall, in order to avoid decomposition and evaporation of the nitrate of silver solution used in the Credé method, advises that the solution be furnished in air-tight ampullæ which contain 0.5 ccm. of a 1 per cent. solution. The solution is dropped by means of an ordinary eye dropper, the lower end of which is filled with a cotton filter. Only 10 drops are furnished, and as 5/6 are retained in the cotton filter, not more than two drops can be instilled into each eye. One thousand cases were observed.

Discussing the prevention of ophthalmia neonatorum, Ernest Thomson concludes as the result of his study:

1. The method of Credé, if carried out correctly in every child born, and followed by prevention of secondary infection, would practically stamp out the disease.

2. Catarrhal symptoms would appear in many cases.

3. Such catarrhal conjunctivitis, provided that its cause is fully recognized, seems a small price to pay for the advantages gained.

4. If 1 per cent. silver nitrate were used instead of 2 per cent., there would be less catarrh and equal protection.

5. Simple cleansing methods of prophylaxis, without the use of germicidal applications to the eyes, are nearly as good as Credé's method, provided the details are faithfully and intelligently carried out, and that infection has not already taken place.

6. Whatever may be done in private practice, the Credé or modified Credé method should be carried out in public institutions.

Von Herff succeeded in reducing the percentage of early infection almost to zero, by the use of protargol, but he found in sophol a still better, milder and yet equally efficient drug. Sophol is described as a silver compound of formaldehyde-nucleinic acid. It was tried with success in a series of 280 cases, and can be recommended for general use, as it produces very slight irritation, and yet is gonococcidal and very stable. It can be furnished in the form of tablets to midwives, without hesitation.

H. Carter Mactier points out that the vagina is practically the only source of infection, and therefore the important matter is to prevent infection from taking place in this passage. He recommends that a tampon of cotton wool soaked in lactic acid be placed in the vagina for twenty minutes or half an hour before the os dilates, provided gonorrheal infection is suspected. After birth, careful cleansing of the external surfaces of the eyelids and the ciliary margins should be practised. If there is no reason to suspect a pathological state of the vagina, Mactier believes that flushing the eyes with a boric acid solution will be sufficient, but if there is reason to suspect infection, a drop or two of a 20 per cent. solution of argyrol, which he prefers to Credé's nitrate of silver solution, should be instilled into each eye. In this respect he finds himself in accord with Darier's recommendations.

The reviewer is acquainted with the practice of three maternity hospitals, in all of which argyrol has been abandoned as a prophylactic agent, because it was entirely unsatisfactory, and a modified Credé's method has been reintroduced.

Stotter calls attention to the carelessness of midwives in delaying the proper treatment of ophthalmia neonatorum, which they are only too apt to attempt to control with domestic remedies. He thinks a midwife should be compelled by law to call a physician in all suspicious cases, and further believes that this affection should be included with the communicable diseases.

H. Wood discusses the disease from its standpoint as a sociologic problem. In this report all phases of the prevention of ophthalmia neonatorum are discussed, with special reference to the registration of midwives, the listing of conjunctivitis neonatorum as a reportable disease, the enactment of needed laws, the distribution by health boards of circulars of advice to midwives and mothers, and the preparation and distribution by the health boards of ampules or tubes containing the chosen prophylactic. The consensus of opinion on the part of both obstetricians and ophthalmologists is that this should be some solution of silver, and the majority prefer a one per cent. solution of nitrate of silver.

Haltenhoff discusses this subject in so far as it relates to the cantons of Switzerland, and summarizes the measures which ought to be used for combatting the spread of ophthalmia neonatorum, and is particularly interested in sending full instructions concerning the dangers of this disease. He also advises a 1 per cent. solution of nitrate of silver as a preventive instillation.

Stephen Mayou states that to nitrate of silver 2 per cent. and bichlorid of mercury, 1 to 2000, should be given the first place in the prophylaxis of ophthalmia neonatorum.

A. Walker, since January, 1908, has been conducting the *treatment of ophthalmia neonatorum* in a ward in St. Paul's Hospital, Liverpool, where both the mother and infant are admitted. This obviates an important obstacle in treatment, viz.: the late date at which the children come under observation; also it gives the opportunity for continuous treatment.

The treatment of fully-developed ophthalmia neonatorum consists, according to Mactier, in frequent douching of the eyes with a solution of perchlorid of mercury, 1 to 10000. He further advises that the conjunctiva should be brushed with a 40 per cent. solution of argyrol and that the nurse should be given a 10 per cent. solution of argyrol with directions to instil it twice a day. The edges of the lid are smeared with iodoform or boric acid ointment. He believes formalin, 1 to 5000, to be a useful application when the cornea is affected. In the event of a relapse, nitrate of silver is used in 2 per cent. solution

for brushing the conjunctiva, and four grains to the ounce for instillation by the nurse.

In the opinion of the reviewer the recommendation to instil a 4 grs. to the ounce solution of nitrate of silver into the eyes of a child with a relapse of gonorrheal ophthalmia is neither wise nor safe.

Greeff maintains that "every case of gonorrheal conjunctivitis, at least of newborn children, is curable."

In the treatment of the cases a 0.1 per cent. solution of nitrate of silver has been used in the Charité in Berlin for some time, with better results than in earlier times with stronger concentrations. The solution is used for irrigation every two hours, day and night, for the critical first few days, and Greeff believes if it is so employed the eyes will certainly be saved.

Bliss regards nitrate of silver as the sheet anchor in gonorrheal ophthalmia and ophthalmia neonatorum, but he uses protargol and argyrol in certain cases after the violence of the inflammation has subsided.

Midwives and ophthalmia neonatorum. The results of some of the investigations of the New York Committee on Prevention of Blindness are given in *The Survey* (Dec. 16, 1911), in which it is noted that in thirty-three of the forty-nine states and territories there is no law restraining the practice of midwifery. In three states midwives are actually allowed by law to practise unrestricted; while in the remaining thirteen states there are laws purporting to require examination before licensure to practise, although there is a total absence in these states of adequate provision for midwifery training. By an act of parliament a Central Midwives Board was established in England in 1902, and the supervision and control of midwives was placed under it. Miss Van Blarcom, executive secretary of the committee, was sent to England to study the working of the law and she found that not only have maternal and infant mortality declined, but in the opinion of many obstetricians and public health authorities in England the morbidity of mothers and babies has been reduced at least partly as a result of the better medical and nursing care secured through the administration of the Midwives Act. The committee believes that there is a very necessary function for midwives to perform, and that the fact that thus far they have not adequately measured up to that function is not a more logical reason for their elimination than for their elevation through education and proper state supervision.

One tangible result of the committee's effort to better midwifery practice in New York has been the establishment of a training school

for midwives in connection with Bellevue and allied hospitals. The report states this to be the first school of its kind in America. The school is under the immediate supervision of the general superintendent of nurses of these hospitals, and its curriculum embraces instruction in practical nursing, care of pregnant and parturient women, care and feeding of infants, conduct of normal labor, symptoms of complications and abnormalities, and the rudiments of anatomy, physiology, hygiene, and dietetics.

Although members of the medical profession sometimes, in their ignorance no doubt, lay the flattering unction to their souls that most of the blindness from ophthalmia neonatorum may be laid at the door of the midwife, yet calm investigation of the question often shows that much, if not most of the trouble, is due to the neglect of the doctor—as will be seen by reading the following abstract.

Under the caption "Saving Infants' Eyes," the *Medical Review of Reviews* (July, 1912) points out the fact that the law passed in Massachusetts in 1905, requiring the reporting of cases of ophthalmia neonatorum, remained a dead letter until 1910, when the State Board of Health was given an annual appropriation of $2,500 to be used for the prevention of this disease. Physicians were supplied gratis with a silver nitrate solution and efforts were made to educate physicians and public alike as to the necessity of preventive treatment. Physicians have been prosecuted and some fined for failure to observe the Reporting Law—ten doctors to date. In a report issued by the Social Science Department of the Massachusetts Eye and Ear Infirmary it is stated that, while babies still become blind, the percentage of neglected cases has been cut almost two-thirds in the past three years. The doctors of Massachusetts and not midwives are mostly responsible for blindness due to ophthalmia neonatorum. Out of 388 cases under observation at this infirmary, 360 had been attended by physicians and only ten by midwives.

The conclusion to be drawn from the foregoing is, plainly, that both midwives *and* medical practitioners need to be constantly reminded of their duty to the new-born under their care.

CONSERVATION OF SCHOOL-CHILDREN'S EYES.

When the time comes for children to attend school the obligation rests heavily upon the shoulders of school authorities to see that schools and school management are as beneficial to the attending scholars as possible.

Schools should benefit children physically as well as intellectually and morally. School authorities should not be satisfied with a mediocre

offering of these advantages; they should be placed at the children's disposal, in the most perfect manner possible.

While fully aware of the importance of the inspection and care of all portions of children's bodies, it must not be forgotten that this work is limited to ophthalmological subjects, and, therefore, whatever is here said about the physical condition of school children and schools, must be limited to their eyes.

There are 20,000,000 public-school children in the United States. At least 5,000,000 of these children suffer from eye diseases or defects which seriously impair their school progress. About 12,000,000 suffer from eye, ear, nose or throat diseases or defects, which prevent proper school advancement.

Children who have defective eyes, ears, noses and throats cannot, unless relieved, receive and profit by public-school education. To such children, schoolwork is a pain and a burden. They are always behind their classes, sometimes remaining in one room year after year, an exasperation to the teachers and discouragement to themselves. Unless relieved and rendered fit for study, they are regarded as mentally deficient and morally vicious, become personally disheartened and truant, drift into bad society and associations, commit small and then greater crimes and eventually may enter the criminal classes and then become an expense and care to the commonwealth as police-court defendants, and as dwellers in asylums, institutions and prisons.

Education is the greatest enemy of crime, and where education is not possible crime is almost sure to raise its ugly head. The war cry against crime should then be "Education," and where education is difficult or impossible owing to physical defects or diseases, immediate steps should be taken to relieve or remove such defects, so that children may be able to receive and profit by education, and thus rear good, valuable and respectable citizens and save millions of money that can then be deflected into desirable channels.

New York City has 650,000 public-school children, and 30 per cent. of these children are two years behind their natural grades. Ninety per cent. of this misfortune is due to defective eyes, ears, noses and throats. Dr. Cronin found in one school 150 defective, backward children, 137 had bad tonsils and adenoids and 13 had defective eyes. These conditions were all removed and almost all the children became good and tractable pupils. This is a striking illustration of what may be done in other schools.

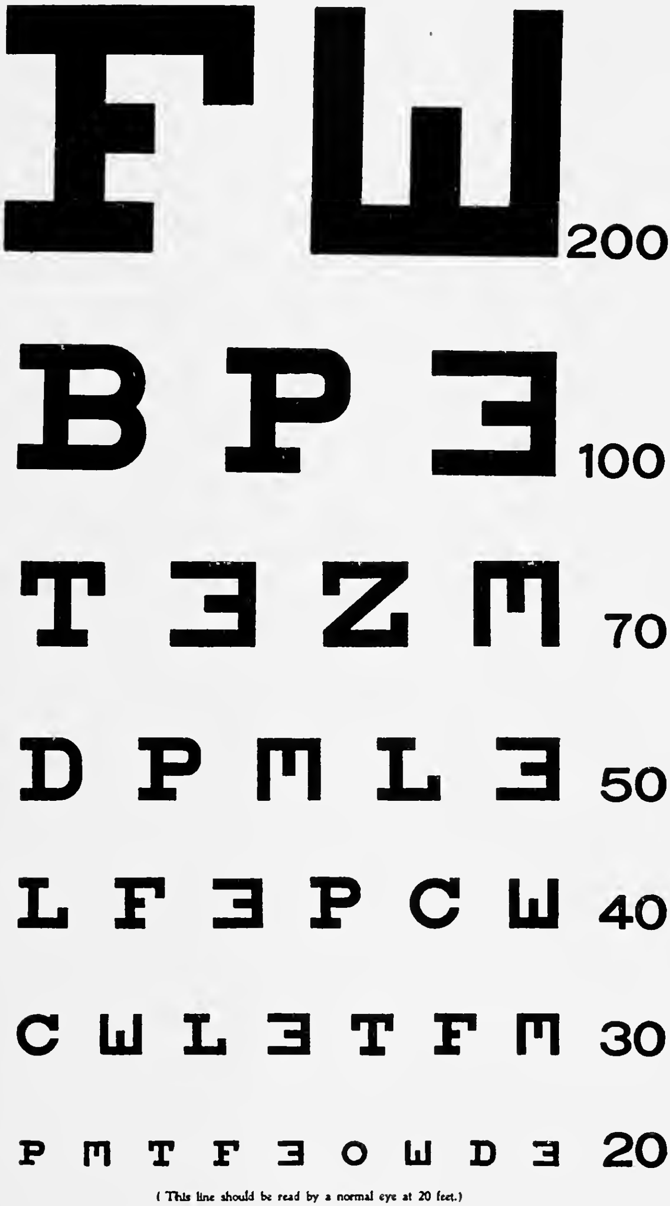
It must not be supposed that eye tests among school-children are merely for the purpose of correcting ocular defects by glasses. Such instances are, of course, extremely frequent, and many children are

retarded in their school-work by near-sightedness or by other defects, such as hypermetropia, astigmatism, muscular weakness, etc., which prevent easy and comfortable eye service, and which are usually followed by laziness, neglect of work, discouragement, truancy, and school abandonment. But there are many other ocular conditions which the school tests will disclose, such as the various forms of sore and red eyes, iritis, ulcers, cataracts, cross-eyes, and tear-duct diseases. Thousands of children already owe their emancipation from such diseases to the ocular examinations made in schools. One need not hesitate to say that every board of health and board of education in this country is committing a moral and social crime if they do not insist upon the annual systematic examination of school-children's eyes, ears, noses and throats.

In many cities a conflict has arisen between the board of education and the board of health as to which one shall undertake this work. The board of health may claim that they have no money to hire a sufficient staff of doctors, or even nurses, to perform the work, while the board of education may claim an insufficiency of funds, or an unwillingness to place this additional work on the teachers. And thus between these two boards the children suffer. Many competent observers believe that this is a matter which should come under the board of health, while others feel that physical defects of this nature are better cared for by the board of education leaving to the board of health all diseases and sanitary matters that threaten the public health. There is no doubt but that tests, examinations, etc., such as the eye, ear, nose and throat tests, can best be made under the direction of the board of education, and that such preliminary examinations should be made by school-teachers.

In order to make the matter easy and practical, Allport has prepared what he calls "A visual chart for schools." This chart contains the usual test letters for testing vision. Each line also contains at least one letter for illiterates, which enables small children who do not know their letters to be accurately tested as to their visual capacity.

The lower portion of the chart contains the teachers' instructions, here reproduced, to demonstrate how easily the tests can be made. This portion of the chart should be torn or cut away from the upper portion, on a line which is properly designated.



Vision (Snellen) Chart for Schools. (F. Allport.)

A Visual Chart for Schools.

The advisability and necessity of examining the eyes and ears of children attending the public schools is now generally recognized by principals and teachers everywhere.

The system which will be described furnishes a simple method whereby the eyes and ears of each pupil may be quickly examined by the teacher, a record made, and, if an apparent defect exists, the parents notified. This system has been annually employed in many cities of this country, and is rapidly being adopted by boards of education throughout the United States and other lands.

For making these tests a card of test letters has been planned, with complete instructions on each card. These cards are printed upon 6-ply Peerless board, 11x27 inches, with eyelet hole for hanging. The lower section, or that part of the card containing instructions and information regarding their use, is made so as to readily be detached from the main body of card.

The object of this is to allow the teacher to have before her these instructions while examining the pupil, with the test letters hanging at the proper distance on the wall.

Instructions for the examination of school-children's eyes; for the use of principals, teachers, etc.:

Do not expose the card except when in use, as familiarity with its face leads children to learn the letters "by heart." First-grade children need not be examined. The examination should be made privately and singly. Children already wearing glasses should be tested with such glasses properly adjusted on the face. Place the Vision Chart on the wall in a good light; do not allow the face of the card to be covered with glass. The line marked 20 should be seen at 20 feet, therefore place the pupil twenty feet from the card. Each eye should be examined separately. Hold a card over one eye while the other is being examined. Do not press on the covered eye, as the pressure might induce an incorrect examination. Have the pupil begin at the top of the test-card and read aloud down as far as he can, first with one eye and then with the other. For the use of those children not knowing the names of letters the sign (ш) has been placed on each line in various positions. The child should indicate in which position this sign is placed. A cardboard symbol (ш) can be easily cut out, which the child can hold in its hand. It should hold the figure in the same position as the one it is expected to see on the chart. For the purpose of convenience each line ends with the sign (ш) in various positions.

Facts to Be Ascertained.

1. Does the pupil habitually suffer from inflamed lids or eyes? 2. Does the pupil fail to read a majority of the letters in the number 20 line of the Test Types with either eye? 3. Do the eyes and head habitually grow weary and painful after study? 4. Does the pupil appear to be "cross-eyed"? 5. Does the pupil complain of earache in either ear? 6. Does matter (pus) or a foul odor proceed from either ear? 7. Does the pupil fail to hear an ordinary voice at 20 feet in a quiet room? Each ear should be tested by having the pupil hold his hand over first one ear, and then the other. The pupil should close his eyes during the test. 8. Is the pupil frequently subject to "colds in the head" and discharges from the nose and throat? 9. Is the pupil a habitual "mouth breather"? If an affirmative answer is found to any of these questions, the pupil should be given a printed card of warning to be handed to the parent, which should read something like this:

CARD OF WARNING TO PARENTS

After due consideration it is believed that your child has some eye, ear, nose and throat disease, for which your family physician or some specialist should be at once consulted. It is earnestly requested that this matter be not neglected.

Respectfully,

———————— School.

If only an eye disease is suspected, the words "ear, nose and throat" should be crossed off; if it is only a nose and throat disease, the words "eye and ear" should be crossed off.

It will be observed that these cards are non-obligatory in their nature. They do not require anything of the parent, who is at perfect liberty to take notice of the warning card or not, as he sees fit. They simply warn the parent that a probable disease exists, thus placing the responsibility on the parent.

If parents neglect the warning thus conveyed, the teacher should, from time to time, endeavor to convince such parents of the advisability of medical counsel. Teachers are urged to impress on pupils and parents the necessity for consulting reputable physicians.

These tests should be made annually at the beginning of the fall term, and should include all children above the first grade.

Each teacher should examine all the children in her own room, and should report the results of such examinations to the principal, such reports to be signed by the examining teacher.

The following simple form of report, to be filled out by the teacher and handed to the principal, is suggested:

Name of pupil. Do the tests indicate an eye disease? Answer "Yes" or "No." Was the pupil given a card of warning?

This plan is simple and uncomplicated, no medical education on the part of the examiner is necessary, and any intelligent teacher can make the tests without the slightest difficulty after a very little practice. Every teacher should annually and systematically examine the eyes, ears, nose and throat of each child in her room. The school board should set aside one day in the early fall for this work. As there are only about forty children in each room, and as it does not take more than five or six minutes to examine a child, it will be seen that a room full of children can be easily examined in one day. Thus by subdividing the work an entire city, of whatever size, can have all its school-children examined in one day. If it is deemed inadvisable to give up a day to the work a few children can be kept after school each day for a week, and the tests can be made in this way. The teacher should have two or three assistants, in order to expedite the work, and these can usually be found among the children themselves. One assistant should stand near the test letters and point them out, another should make out the "Warning Cards to Parents," etc.

No teacher should complain of this work, for she is the one who is the most benefited by it. One child who through some uncorrected eye, ear, nose or throat defect continually lags behind his class and becomes idle, mischievous and disturbing, will cause the teacher more

trouble in the course of a year than would the making of these tests. They are really labor and nerve-saving devices and the teachers ought to recognize this fact and encourage them. This has been the case where the tests have been systematically carried out.

The annual, systematic, preliminary examination of school-children's eyes, ears, noses and throats by school-teachers, is an agency of enormous and incalculable benefit to the children, to the parents, to the community at large. Then why not universally benefit by it, especially as the cost is insignificant? The only expenses are the testing charts, which can be purchased for $5.00 a hundred, "Warning Cards," and the simple record blanks which cost almost nothing. If medical inspectors had to be hired to do this work the lack of funds might prove an embarrassment. But medical inspectors are not necessary, as the teachers can do it perfectly well, and by answering the nine simple questions at least 95 per cent. of serious eye, ear, nose and throat diseases will be detected. This is all the teacher has to do; she is not expected to ascertain the nature of the child's complaint; the doctor consulted will perform this function.

In some communities, especially in New England, they have been trying the experiment of employing one or two school-nurses of exceptional ability and tact, to act not only as medical inspector, but also as school-nurses. They look for defective and diseased children, urge the parents to take them to their doctor and then do what they can to follow out the doctor's instructions. They also assume supervision over hygienic and sanitary conditions in the schools and in the homes of the children. In many places the eye, ear, nose and throat tests are made by these school-nurses and the plan has worked admirably. Indeed, the entire plan of substituting trained, experienced and tactful schoolnurses for medical inspection in small places has much to recommend it, and is well worthy of a careful trial.

OCULAR HYGIENE IN SCHOOLS.

Closely related to the eyes of school-children is the subject of ocular hygiene in schools, and no one is more familiar with this problem than S. D. Risley, of Philadelphia. To him therefore we turn for our information.

The greatest value of the medical profession to the community lies in its work for the prevention of disease rather than its cure. One of the most fruitful fields for this endeavor is found in the schoolroom. This has been abundantly demonstrated by preventing the spread of contagious disease through the daily inspection of the children for the detection of the early stages of communicable diseases;

e. g., sore throats, measles, scarlet fever, diphtheria and infectious diseases of the eye, the most common of which is trachoma. Equal in value has been the detection of physical defects; e. g., impaired vision and hearing which hamper the school progress and are not infrequently the cause of headache and a considerable group of nervous symptoms.

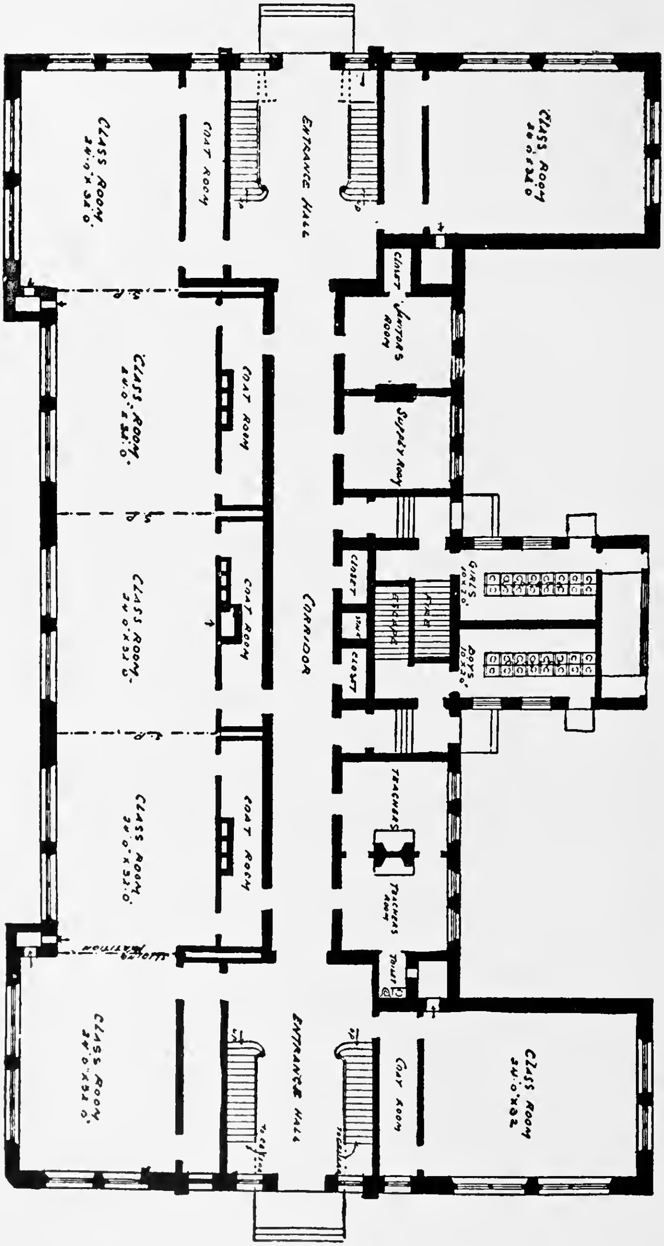
This is especially true of congenital defects of vision. The great importance of these faulty conditions of the eyes of our school-children is obvious when it is known that normal eyes are comparatively rare; extensive and careful examinations of large numbers of growing children both in Europe and this country having shown that only from ten to twelve in every hundred are born with model eyes. The remaining eighty-eight or ninety have defects of some kind, varying in degree, which either cause impaired sharpness of sight or render the act of seeing more difficult than with the normal eye. In many cases the defect is slight, but in about sixty in every hundred of these defective eyes it is sufficient to cause pain, to lower the sharpness of vision and to imperil the health of the eye during the progress of the school life.

The known existence of these troubles in so many of our school-children's eyes has led the school authorities, acting on the advice of physicians, to advise and, in some sections of the country, to require, that no child shall be admitted to the school until the eyes have been examined by some competent person. If the eyes are found sufficiently faulty the parents are advised to seek the advice of a physician. After these examinations for physical defects or disease have been made and the children are admitted to the school it is important that the school-house shall be so constructed and the school-room so arranged that in all respects it shall be a suitable place for the children to spend, safely and comfortably, the many hours daily required through the years of their school life.

The importance of suitable education for children was recognized early in the history of the republic. Our school system has been properly regarded as one of the bulwarks of the nation. But of what avail will it be if the children graduate from school with impaired health, distorted spines and injured eyes?

The educational process covers the years of physiological growth and development and therefore should be so directed that normal physical development shall not be hampered or disturbed. In a word, the education or development of the mind must not be done at the expense of the general health and well-being of the body.

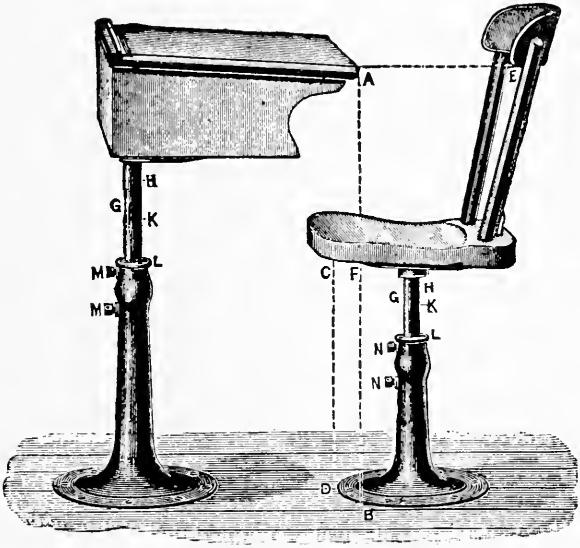
To this end, properly situated, planned and constructed school



Ground Plan of a Model School Building. (Risley.)

buildings are essential. In selecting a site for a school building two things are important. First, that it shall be erected on a soil that can be kept dry by suitable drainage. This is especially important in villages and rural districts. Second, it should be in a relatively open space, so that the sunshine, light and air will not be shut out or interrupted by large trees or contiguous buildings; it should not be in the immediate neighborhood of railways or manufacturing establishments.

The architectural plan of the school building is of signal importance and must be based on the essential requirements of the schoolroom.



Adjustable Table and Desk for the Prevention of Eye-strain. (Risley.)

These must not be sacrificed to make the external appearance of the building conform to some adopted system or scheme of architecture.

The proper requirements of the schoolroom cluster to a surprising degree about the problem of appropriate lighting of the room. The light must be sufficient, so that even on cloudy days fine print can be read with ease by the normal eye in every part of the room. Experience has shown that, in order to secure this, the uninterrupted window-space must be as one to five of floor space. On bright, sunny days, with the sun's rays falling on the windows, the light should be modified and glare prevented by suitably arranged shades at the windows. Second, the room itself should be so placed in the building that the seats can be arranged in such a manner that the

light from the windows shall fall on the desks and seats from the left of the pupil and that the wall space free from windows shall be in front of the pupils and to their right side. On this wall space the blackboards, maps and pictures used for purposes of instruction and illustration should be placed. In a schoolroom arranged and lighted in this manner the children are not compelled to face the source of light, while the work on their desks is well illuminated and there are no annoying cross lights. The blackboards and other teaching appliances are also well lighted and exhibit no annoying reflections of light.

In the construction of suitable school-buildings provision should be made for a well-lighted and well-ventilated cellar under the entire structure, the floor of which should not be more than three feet below the surface of the ground and its ceiling not less than eight feet from the floor, which allows space above the ground for the windows. The cellar walls should be constructed with a water table and both floor and walls cemented in order to exclude all dampness. The windows should be ample in size and sufficient in number to secure good lighting and drafts of air in dry weather.

The best plan for large buildings is that which provides for their construction around a large, open central square or quadrangle one or more sides of which can be utilized, the other sides of the square being covered as the growing demands of the neighborhood may require. The sides of the building next to the central open square should be devoted to corridors, teachers' rooms, the executive department of the building, toilet rooms, fire escapes, etc., while in the square are located the smokestack, heating apparatus, machinery for forced ventilation and a vacuum cleaning apparatus. The outer side of the structure can then be devoted exclusively to schoolrooms, which succeed each other in an unbroken series from left to right around the entire outer side of the structure. In such an arrangement the children are all seated with the windows on their left side and facing the end of the room free from windows. The figure gives the ground plan of such a structure, and the elevation on such a foundation showing the model school building with roof garden for sports and recreation. With proper attention to detail the partitions can be so constructed that any given series of these rooms can be thrown into one or more large assembly rooms to meet special demands. The general plan gives also ready access from each room to toilet facilities, coat-rooms, luncheon rooms, etc., arranged along the enclosing corridor. The floor should be of hard wood, properly filled to facilitate daily cleaning and to prevent the absorption of noxious substances. The coat-rooms and

toilet-rooms should be so equipped that there shall be ample facilities for hanging the outer garments of each pupil in a dry, warm and well-ventilated room. This is important, especially in damp weather. Wash basins, with a free supply of running water and without stops for the waste should be provided, and individual towels or paper supplied for drying the hands and face.

Not only is sufficient and suitable lighting of great importance in the conservation of vision, but also the arrangement of seats and desks. Not only must they be so placed that the light shall fall on the desk from the left side of the pupil, but the desk and seat must sustain a definite relation to each other and to the size of the child. The seat should be so placed that a line falling from the edge of the desk will fall on the seat as shown in the cut. The seat and desk should both be susceptible of adjustment to the size of the child. With such a desk, pupils will find less temptation to assume faulty positions while at their work.

There is much to be said regarding the exposure of the schoolroom. In most sections of the country it is preferable that the corridors should run north and south, giving an eastern, southern and western exposure to the schoolrooms, so that at some time during each day they will be bathed in a flood of sunshine. The greater cheerfulness and warmth of sunbathed rooms and their comparative healthfulness are not open to question. In such a room the pupils will be brighter, more cheerful and orderly. The direct rays of the sun should not be permitted to fall on the desks, but this can be controlled by a suitable arrangement of shades. These should be of neutral tint; light gray, straw color or gray-green are suitable for the purpose. The walls should be finished with a smooth, hard, non-reflecting surface and decorated in neutral tints of gray, gray-green or straw yellow. These neutral shades of color, properly chosen, do not absorb the light and add to the beauty and cheerfulness of the room. These colors should be secured through the application of oil paints, so that the surface can at stated intervals be thoroughly cleansed. The walls and ceiling of a room occupied by a class of pupils many hours daily are soon covered with a coating not only of dust but of organic matter deposited by the breath and exhalations from the body, and should from time to time be washed to prevent the spread of contagion. The utmost care cannot prevent entirely the presence in the schoolroom of innocent and unsuspected carriers of various forms of contagious disease. It is of signal importance that a systematic, orderly and scientific method of cleaning the school building in all its parts at regular intervals throughout the year should be adopted.

It is probable that the best and most economic method would be the installation of vacuum cleaners throughout the building. This would prevent the stirring up of dust into the atmosphere of the rooms, as in sweeping, to settle on the walls and furniture. This would not avoid the necessity of regular mopping of the floors with cloths wrung out of antiseptic solutions. The furniture, wainscoting, etc., should be dusted daily, not with a feather duster or dry cloth, but with a damp cloth, wrung out of some antiseptic or disinfecting solution.

To secure thorough cleanliness, every school building should be subjected to regular inspection by a competent and rigid inspector.

ILLUMINATION AND EYESIGHT.

Intimately connected with school work, as well as with life in homes, offices and factories, and other public buildings, is the important subject of illumination.

It is a far cry from the old rush lights, candles, etc., to the modern and efficient methods of lighting. There is still much to do, however, not only in further improving artificial illumination, but in insisting upon the use of those effective methods of illumination which are already available.

Thousands of eyes are annually injured by glaring or insufficient lighting, when healthy and satisfactory illumination can be had—almost for the asking.

The writings of E. M. Alger, of New York City, whose investigations along these lines have made him an authority upon this subject, are largely quoted in this connection. The illustrations are taken chiefly from the *Transactions of the Illuminating Engineering Society,* by permission, and especially from the booklet entitled, *"Light, Its Use and Misuse."*

As we know more of the psychological processes involved in either work or study, we realize that, if one is to make any adequate use of his powers, he must see distinctly and without abnormal fatigue. For this reason, the last decade has seen a great deal of study applied to the practical conditions which affect both visual acuity and comfort. For the most part these studies have been directed to the diseases and functional defects of the eyes themselves, the literature on such subjects as myopia and eye-strain and their relation to efficiency being very voluminous. Until recently, however, no very great attention has been paid to the conditions under which the eyes were to be used. We are just beginning to appreciate that ability to use the eyes may vary within wide limits as the conditions are favorable or unfavorable, and, as a result, a critical investigation of the factors in this

ocular efficiency is in progress. One of the most important of these factors is certainly illumination, and we are getting farther away from the old idea that the best lighting system is the one that gives us the most light for the least money.

Our factories, offices and public schools have always depended chiefly on natural light, this probably being a determining factor in the hours universally chosen for both work and study. But there are many situations in which it is impossible to get good natural illumination during the working-day or where it is desirable to utilize the expensive plants for work at night, so that most modern buildings are designed to be artificially lighted when necessary. The illumination of most buildings, whether public or private, has been planned by the architect, frequently without expert knowledge, and so made a subordinate feature. The location and capacity of lighting fixtures and even of windows is too often considered from the standpoint of decoration rather than utility. While there is much dispute over minor details, the general principles of illumination are pretty well established, and apply not only to schools, but to the factory, the office and the home. Let us consider for a moment the physiological standards under which we must judge the value of light, whether it be natural or artificial.

Intensity. When light falls on the retina it excites certain photochemical changes, which are proportionate to the intensity of the light and the length of the exposure. A light may be so dim as to cause too little reaction for us to perceive it, while, on the other hand, it may be so strong as to exhaust the visual purple and leave the eye temporarily incapacitated. We seek a happy medium, though the amount of light needed will depend largely on the nature of the task pursued and the sensitiveness of the eyes employed. The efficiency of the illumination should never be judged from the brightness of the light alone, but from its effect on what one is trying to see. One can learn to determine for himself, in a rough way, the amount of light he needs by gradually increasing the illumination until further increase fails to improve the sharpness of vision. Evidently, less light will not permit the maximum of acuity, while more wastes the visual substances and lessens the maximum of use. To be more exact in our measurements, we have a number of so-called photometers which enable us to compare the brightness of light falling on any given spot with the light from a standard candle one foot away. But after all is said and done, the human eye is one of the best photometers if one is careful not to injure it in the process, since it is on its adaptability to that eye that all light must ultimately stand or fall. Some eyes need more light than others, but, in a general way, we can say that

from two to three foot candles is illumination enough for ordinary school and office work, though this will depend somewhat on the color of the walls and the work and the general brightness of the room. Within limits, the retina, as we say, "adapts" itself to extremes of light, so that one can become accustomed to working in a light which dazzled him badly at first and can, after a time, see surprisingly well in light which is not far from absolute darkness. Intense and long-

The Light Is Too Bright and Shines Directly Into the Eyes, While the Rest of the Room Is Too Dark. Notice the deep shadows and the glare.

continued exposure to bright light causes retinal exhaustion and the retina becomes capable of reacting only to powerful stimulation. In other words, that retina is for the time being blind, except in the brightest of lights. Every one has experienced the comparative blindness caused by going from bright sunlight into a dimly lighted room. It is a common experience to have workmen insist on having as intense a light as possible because they have temporarily so blunted their retinal sensitiveness that they are helpless without it, and it is generally the hardest kind of a task to convince them that even if they

suffer no harm from the glare they cannot possibly work as long without fatigue. In another set of people, the retina, instead of being blunted, becomes hyperesthetic, and finally almost incapable of bearing any exposure to light at all. This condition is seen at its worst in hysterics, when it is, of course, not a result of overlighting. But there are a number of occupations, like those of the gilders and polishers, who have their attention fixed for long periods on bright surfaces, in which retinal weakness is very common. Indoor workers as often suffer accident from too much light as from too little. Exact photometric measurements show that the light of ordinary incandescent

A Good Reading Position.

lamps concentrated at the cutting point of a tool or a work-bench is often several times the intensity of daylight. But the eye adapts itself to this intensity and when the workman turns from his overlighted work, perhaps in a room full of moving machinery, he is practically blind. What is needed from the point not only of safety, but of health and comfort, is much less intensity and much better diffusion of light.

Diffusion and steadiness. The human eye is normally exposed to so many variations of light that it has developed in the pupillary reaction a beautiful mechanism for automatically regulating the amount of light admitted, and so making easier the retinal adaptation.

But the change from bright light to dim, and vice versa, is always uncomfortable if it is sudden or extreme, and also causes a tremendous falling off in the visual efficiency for the time being. This is particularly true of a flickering light, which passes so rapidly from one extreme of illumination to the other that it causes very rapid and extreme movements of the iris, and results in a profound fatigue of both retina and muscles.

So far as the eye is concerned, the apparent intensity of a light depends very largely upon the luminosity of its surroundings. A match suddenly lighted in an absolutely dark room may be positively painful in its momentary brightness, while in daylight it would hardly be noticed at all. A bright light near the line of sight not only keeps distracting the attention, but causes dazzling and discomfort out of all proportion if its surroundings be relatively dark. It also makes a great difference in vision. Inability to see objects when facing the headlight of an automobile is a familiar illustration. The difficulty of seeing a face across a dining-table when a lighted candle intervenes is another. From the physiological standpoint, therefore, it is a great mistake to attempt to work with a relatively bright light of any kind shining directly into the eyes.

An intense light from a small source throws a strong shadow, while the same amount of light diffused or coming from several sources would cause a relatively faint shadow. Now, shadows are necessary, for most of our ideas of height and depth and relief are visual judgments based on shadow formation, and our judgments are naturally more correct when the depth of shadow is that to which we are accustomed. A photograph very often fails to resemble the original, not because the camera lies, but because the picture is taken in a light different from that in which the sitter is ordinarily seen. This is, of course, the reason that the artist and photographer prefer a north light, which is well diffused and gives us our nearest approach to a universal standard of light and shade. Daylight has a vast volume and is diffused so that objects get light from all sides, and shadows are reduced to a minimum. Artificial light can hardly be expected to secure thorough diffusion any more than comparative freedom from shadows, but in many industries almost no attention has been paid to this point. And yet it is most important, for Calder, in an interesting paper, has shown that the retinal anesthesia and deep shadows that result from poor artificial lighting are potent factors in causing industrial accidents.

The relation of color to illumination. The light in which they are seen affects not only the form of objects, but their color as well. Ordin-

ary white light, consists of a mixture of vibrations or waves in the ether, which, according to their length, give us the various colors of the spectrum. We say that an object is red, not because it actually is red, but because when seen by daylight, it reflects or transmits only the long rays, which in the average person excite the sensation of red. If seen by light of another wave length its color would be entirely different. None of our artificial lights has exactly the same spectrum as daylight, and every woman knows that the color of her gown, and even of her face varies with the light in which it is seen.

Actinic effects. There are other waves besides those of the visible spectrum, longer ones than the red which can be felt as heat and

The Formation of Shadows When the Light Is Well Diffused and When It Is Badly Diffused.

shorter ones than the violet which can exert a very active chemical action.

Many of the effects of sunlight which were once attributed to heat are now known to be due to chemical activity. For instance, in snow and desert blindness, the light is broken up by reflection from the crystalline snow or sand, and the actinic waves produce intense inflammation of the conjunctiva, which, if long continued, results in total disability. Even in temperate climes one suffers more or less from glare and burn from direct or reflected sunlight.

It is quite possible, however, that the delayed actinic effects of light, whether natural or artificial, are much more serious. The ultraviolet rays are arrested by ordinary glass, and in the eye by the tissues of the cornea and lens, so that the deeper structures of the eye escape

harm, but there is strong reason to suspect that their constant absorption by the lens may be one of the causes of cataract. Experimenters have been able to demonstrate changes in the eyes of rabbits exposed to such lights; and it is known that stokers and glass-blowers, who have to face brilliant incandescent light, have a tremendous predisposition to cataract. In the ordinary cataract of old people the first changes generally occur in the lower inner quadrant of each lens, which is the part least shaded by the brows and so most exposed to sunlight from above, and when cataracts develop in people who have one light and one dark eye it invariably appears first in the one unprotected by pigment from the light.

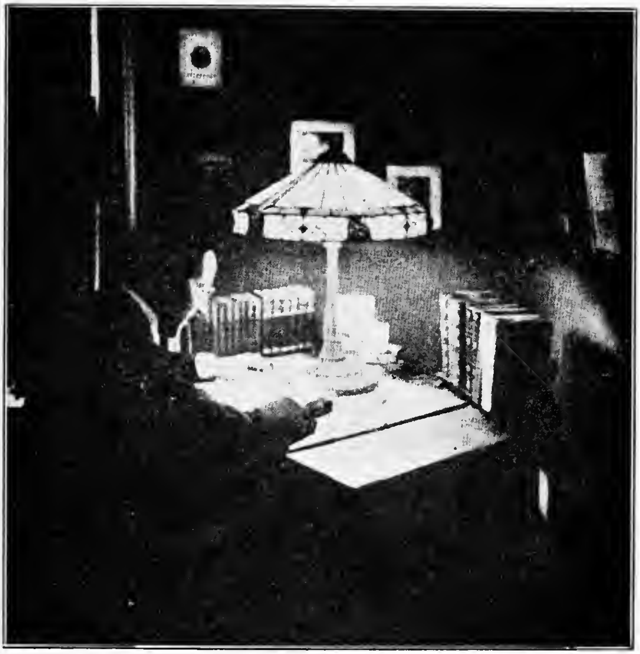
Even if the ultra-violet rays do not reach the deeper structures of the eye, one must not forget that the shorter waves of the visible spectrum have decided actinic properties. Many people have had their eyes permanently ruined by incautious watching of an eclipse, and similar damage sometimes follows exposure to electric flashes and even to long exposure to the arc light. In such cases the light is condensed on the surface of the retina resulting in local inflammation and degeneration, that particular spot becoming permanently blind. A good deal of evidence has accumulated of late which indicates that the infra-red rays, too, which were long supposed to be chiefly heat rays, are capable of irritating the eyes.

Oculists suspect, though they cannot prove, that long-continued light irritation may be a factor in many degenerative changes in the retina and choroid, and advise both the use of amber glasses and shades of such composition as to soften the light and exclude the actinic end of the spectrum. To people who are at all sensitive to light they are a great comfort.

Glare. The effects of light on the eyes are practically the same whether it shines directly into them or is reflected into them. If the reflecting surface is polished, practically the whole amount of light reaches the eyes, while if it is a rough or mat surface the light is broken up and reflected in all directions, while the details of the surface itself become visible. If one looks at a reflection of the sun in a mirror he is in effect looking directly at the sun, while if he substitutes for the mirror a printed page the direct reflection or glare is in proportion to the polish of the paper, while the visibility of the print depends on the character of the mat surface. The eye is much more sensitive to glare coming from below, as from water or from sand, and it is quite possible to have light enough reflected from a polished desk top or from shiny white paper to cause perceptible discomfort

and fatigue. This is particularly true of the intense light reflected from the bare filament of the incandescent bulb.

Abnormal fatigue is admittedly one of the greatest predisposing causes to most diseases, be they physical or mental, and though the part played by bad lighting is perhaps not clear cut, it is beyond doubt. In most factories, schools and offices the eyes must be used constantly for work of a character they were never intended for. The result even in normal eyes is a muscular and nervous fatigue which is measurably increased by both over or under lighting. The first



Bad Reading Position; the Excess Light is All Reflected into the Eyes.

engenders fatigue from retinal exhaustion and pupillary spasm, while the second results in the strain that follows sharp focussing and constant attention. In the majority of individuals whose eyes are handicapped by astigmatism or other refractive errors, the strain is still greater.

The overlighting, which is so common today, may conceivably have other effects. Woodruff has shown that in the tropics blondes who are unprotected by skin pigment are overstimulated by the bright light and finally develop a characteristic nervous exhaustion. It is quite possible that eye-strain and the constant exposure to intense

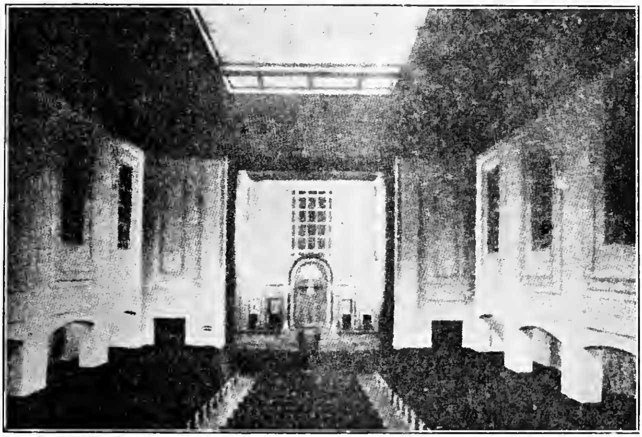
light of short wave-length may be predisposing factors to the neurasthenia from which our garment-makers admittedly suffer.

Even when estimated by its actual cost in dollars and cents, bad lighting is often more expensive than good, but from the standpoint of efficiency there is no comparison. Bad lighting undoubtedly causes unnecessary strain of the eyes and consequent premature muscular fatigue; it compels closer and more constant attention to the details of work, so that tasks which should be done almost automatically and without mental effort are done consciously. Under such circumstances the output of each individual is manifestly less than it should be, there is a larger percentage of mistakes and material spoiled, and the number of accidents, large and small, is vastly increased. Even under the best of conditions, the extreme subdivision of factory work, with its consequent monotony, largely destroys the pleasure of work, but bad eyes and poor lighting and long hours are important factors in the industrial discontent of the day.

Daylight illumination. When available, the light of day is, up to the present time, by far the best illumination for the school, the factory or the home. It is the natural illumination to which our eyes through generations of evolution have become accustomed. A good north light is the best diffused and causes a minimum of shadow. It is subject to no rapid changes in intensity, and, so far as color values are concerned, it is the universal standard. It is least trying to the eyes and allows a maximum sharpness with a minimum of fatigue. The best lighted room would be one lighted on the principle of a photograph gallery. Where land is cheap and a one-story building is possible, this principle can be applied in the so-called saw-tooth type of construction now used in so many factories, the entire roof consisting of rows of skylights facing toward the north. In buildings of more than one story the use of north light alone is impracticable, since all the rooms cannot face toward the north, or other buildings may interfere with the light, while, unless the room itself be small or high-posted, the light would not reach far enough into the room. This particular difficulty can be largely overcome by the use of prism glass in the windows, which throws the light much farther back into the room. Windows should be as large and as high as possible and on only two adjoining sides of the room. This permits the arrangement of desks and work so that each person may get his light over his left shoulder, which is the accepted position of greatest efficiency. No one should be compelled to sit steadily facing a window or light of any kind. A north light is practically never bright enough to require reduction, but when the windows face in other directions the intensity

of the light will vary widely with the position of the sun, and arrangements must be made for diffusing and modifying the direct sunlight during some portion of the day by the use of frosted glass or the interposition of thin shades of cloth, which diffuse and soften the light.

In a studio, where more exact modification of the light is necessary, several thicknesses of cloth are arranged so as to be used separately or together, as desired. In the schoolroom these shades can be colored a neutral tint of yellow or green. Reflected sunlight is just about as trying as direct, and the wall blackboards and even the desks should be studied from this point of view. The walls should be covered with



Good Illumination. The Light Sources Are Outside a Skylight of Diffusing Glass.

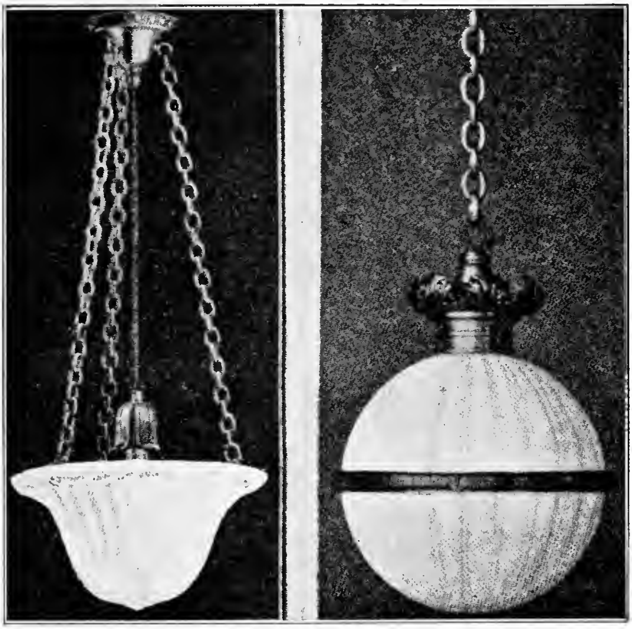
a rough finish of some sort. Perhaps a waterproof cloth makes as good a wall covering as any. It is inexpensive, can be washed at will and painted any color desired. This color must be adapted to the room; a dark color, which absorbs much light, being possible only in rooms which are naturally very bright. Ordinarily, light neutral yellows and greens are preferable. Blackboards should also have a rough surface, the avoidance of glare from polished surfaces being one of the cardinal points in good illumination.

Artificial lighting. As compared to daylight, artificial light has some obvious disadvantages, but some advantages as well. A north light has an enormous volume of light of not very high intensity (from 2 to 3 candle-power) but it is so diffused that it gives an even, steady illumination. Most artificial lights have a small volume and a high intensity, so that the area near the light is overlighted, while that farther away is correspondingly dark. A Welsbach mantle has an intrinsic brilliancy of 35 candle-power per square inch, while that of

the tungsten filament itself of the electric incandescent is not far from 1,000 candle-power. In daylight the shadows all fall in the same direction and are of equal density, while such uniformity is impossible with artificial lights. Furthermore, the spectra of artificial lights are never exactly like that of the sun, so that each one has its own peculiar effect on color values. Most artificial lights contain a much larger percentage of the short violet rays, which are correspondingly irritating to many eyes, while experiments show conclusively that ocular fatigue comes on much more quickly than with daylight. But the advantages of having a light which can be used just when it is wanted, just where it is wanted and in the exact quantity and form desired are so obvious that illuminating engineers have long been engaged on the fascinating problem of constructing a light which should, in as many respects as possible, be like that of the sun and yet be subject to human control. So far they have not succeeded, but the immense advances that have been made in the last decade give us every reason to hope that we shall eventually reach the goal. Three types of artificial lighting are in general use: the direct, the indirect and the semi-direct. In the first, the light is designed to fall directly on the work. In the second it is directed first onto the walls and ceilings and thence reflected to the work, while the third aims to combine the two, part of the light being thrown on the work and part on the walls. Each method has its advantages and its disadvantages, which will be alluded to later on. But from the physiological point of view, the efficiency of a lighting system can be judged in two ways, from its effect on visual acuity and from its effect on endurance. The interesting laboratory experiments of Ferree (*Trans. Illum. Engineering Soc.*, 1913) seem to show conclusively that, so far as mere acuity is concerned, it is higher in daylight than under any artificial light of the same candle-power, while the indirect, the semi-direct and the direct follow very closely together in the order named. When it comes to endurance and distinct vision for a period of time, diffusion seems to be by far the most important element of light. In daylight and in the indirect system which give the best diffusion, the eye does not tire readily, but maintains its efficiency through a very wide range of intensities. Under semi-indirect lighting the eye tires rapidly, except when the light is maintained at about 1.7 candle-power, which, however, does not permit the maximum visual acuity. For the direct system no intensity could be found at which the eye did not lose a great deal of its efficiency after a period of work.

Electric lighting is still in its infancy. For the present, at least, some form of lighting by incandescent bulbs seems to have more

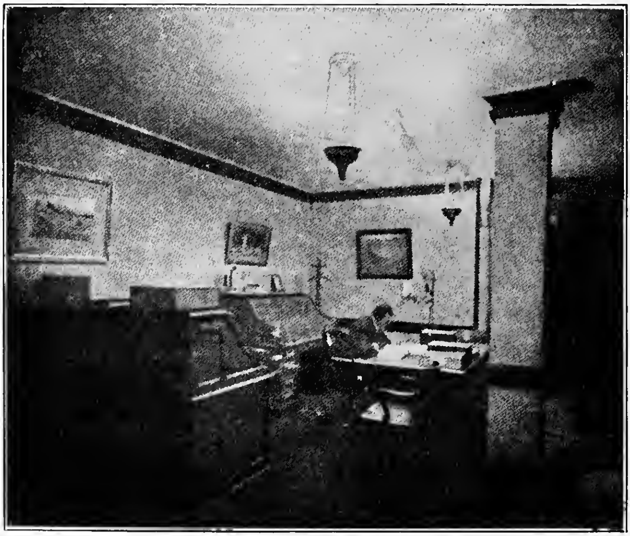
advantages and fewer disadvantages than any other. It can be used in three ways: the so-called "direct," the "indirect" and the combination of the two. For direct lighting, the incandescent bulbs offer the advantage of small units, which can be distributed where needed and so secure an even illumination as well as a steady one. The great disadvantage is that their intensity is great and it is difficult to place them so that some eyes at least are not exposed directly to their glare. Rooms lighted by large numbers of bare lamps are in practice very tiresome to the eyes, because of the extreme brightness of the filament



Diffusing Shades. The light appears to emanate from the whole globe instead of its central point. The same idea can be applied to gas lighting.

(1,000 candle-power per square inch), and they certainly interfere with ocular efficiency. This can be obviated by using frosted bulbs, or better, still, by enclosing each bulb in a frosted or a prismatic glass globe, which directs and diffuses the light, so that it seems to come from the surface of the whole globe instead of the small central lamp. Globes which show the outline of the lamp filament are only partly effective. It would be perfectly possible to have an individual light on each desk so controlled by an opaque reflector that it lighted the desk properly and was at the same time prevented from shining directly into the eyes of any one. The same effect is secured, for all

practical purposes, by having lamps scattered over the ceiling or suspended from it, each enclosed in a diffusing globe of some pattern. The amount of light on each desk should rarely be greater than three candle-power, nor less than two. As a rule, wall brackets are not advisable, unless they can be placed high up. The so-called "indirect" system aims to secure the same diffusion of light by having the units so disposed that the entire light falls first on the ceilings and walls and is thence reflected into the room. In this way, if the surfaces are rough, the light is completely diffused, while its color is modified as



Indirect Lighting. Lamps concealed in opaque reflectors and the light diffused from the ceiling.

desired by tinting the wall surfaces. Indirect lighting is a pleasant way of lighting a large room where a comparatively low illumination is called for. In a schoolroom, where plenty of light is needed, it is comparatively expensive, since only a small part of the emitted light reaches the desks, the rest being expended in lighting the upper part of the room or absorbed by the reflecting surfaces. Their color is an important detail, since even light-colored surfaces seldom reflect over half the light, while with dark ones the amount may fall to 10 or 15 per cent. Indirect lighting therefore, requires for the same amount of floor illumination a much larger number of lamps. Many engineers advocate a combination of direct and indirect lighting, sometimes spoken of as the "semi-indirect," in which part of the light is reflected

onto walls and ceiling and the balance diffused through frosted globes or other similar devices.

Arc lighting. This has not been very successfully applied to conditions requiring much use of the eyes for close work. It is far too brilliant for use, unless it can be located much further from the eyes than the comparatively low ceilings of most rooms allow. Its brilliancy, deep shadow formation and its tendency to flicker restrict its use to the lighting of streets and to such industrial plants as foundries and

The Absorption of Light by Dark Walls. Each of these rooms receives the same amount of light.

lumber-yards. Various forms of the mercury vapor lamp have been utilized in manufacturing plants with great success and they may eventually be adapted to school work. For the present, however, this light, while cheap and efficient from the visual standpoint, is rich in ultra-violet rays, and is depressing by its unnatural greenish color.

Gas lighting. This was being rapidly displaced by electricity up to the time when the incandescent mantle came into use. This is for all practical purposes the equivalent of the electric bulb, except that its intrinsic brightness is much less (35 candle-power per square inch), and it can be used with the same precautions against glare both in the direct and the indirect methods of lighting. Gas has, however, several

distinct disadvantages. It consumes a vast amount of oxygen from the room and it emits a great deal of heat, so that its use creates special problems in ventilation. The old open, naked gas jet has largely gone out of use for illumination purposes. Its light was not bad in itself, but for the even lighting of a whole room it is both wasteful and inefficient, to say nothing of its vitiation of the air and the constant danger of acute or chronic gas poisoning in case of leakage.

THE PRESERVATION OF EYE SIGHT BY THE WEARING OF GLASSES.

The wearing of properly-fitted glasses when necessary to avoid eyestrain, is one of the surest means of conserving vision, and the importance of this subject is fully brought out in numerous sections of this *Encyclopedia.* Mothers and fathers often foolishly, even wickedly, object to the wearing of glasses by their children. Older people frequently decline to wear glasses, because they are unbecoming, or because they claim that once glasses are fitted, they can never be discarded, or because of some other equally illogical or unreasonable excuse.

When glasses are needed they should be worn, but they should be prescribed by an ophthalmologist and not by an optician, or a clerk in a store. The glasses should be purchased of an experienced optician and carefully and properly adjusted by him.

THE COMMONER FORMS OF ACCIDENTS TO THE EYE AND THEIR PREVENTION.

So many accidents, great and small, are liable to occur to the eye that it is practically impossible to enumerate them. Indeed it may be said that most ophthalmologists have seen such peculiar injuries affecting the eyes that they seem to be unique.

There are, however, certain "standard" accidents, if the term may be permitted, that occur with sufficient frequency as to be seen from time to time by all ophthalmologists. It is accidents of this nature that will now be considered, and we acknowledge the assistance of E. C. Ellett, of Memphis, Tenn., and Harold Gifford, of Omaha, Nebr., in elaborating the subject.

This is a phase of vision conservation that is of the utmost importance, for most accidents are preventable, and patients often recover from ocular injuries if the eyes receive proper and immediate treatment.

Many of the 100,000 blind people in the United States became so as the result of accidents. It is with these accidents, not including industrial accidents, that this section will deal. By this is meant such accidents as might happen to anybody. Suggestions will also be made as

to what to do with the means likely to be at hand so as to reduce the evil consequences of such accidents.

Accidents which result in bodily injury are lamentable occurrences, especially if they are preventable accidents, and while they do occur, as the adage says, "in the best regulated families," they are so much rarer than in the less well regulated ones that the former must feel on the whole compensated, in this respect at least, for the trouble incidental to the regulation. Accidents which would be minor affairs if expending their force on the head or hand or foot, become most serious when, by virtue of its exposed situation, the eye is injured.

Who has not had a cinder or other foreign body in the eye? This is, by all odds, the most common accident that happens to the eye. Besides being very painful, it is a thing of really serious possibilities, and should be promptly removed. The danger arises from the possibility of infection. These little particles of cinders or sand may start a serious ulceration which may affect the sight. The particle may usually be readily seen and easily removed by any one who has good sight. The corner of a handkerchief is a favorite instrument, and a little cotton wound on the end of a match or tooth-pick is also quite effective and usually at hand. Unless the particle comes away easily it had better be left to expert hands. It often happens that no foreign body can be seen on the eye, but the painful sensation is present. In that case if the upper lid is turned the cinder will often be found adhering to it. It would be hard to tell exactly how to do this, but it is one of the simple things that every one should learn how to do.

Insects sometimes get in the eye, and many of them are very painful on account of an acid secretion which they throw off. The offender can usually be readily seen and removed. Washing the eye freely with water will remove the irritating secretion.

Just as soon as we had gained a struggle over the deadly toy pistol, the deadly golf-ball came to plague us. A number of cases have been reported in which people have cut open golf-balls to see what was inside, and have found there a small sac full of acid, which has squirted into the face of the explorer, with sometimes serious results to the eyes. The United States Golf Association has sent out printed notices warning people of the danger of this accident, and steps will no doubt be taken to stop the manufacture of the balls in this manner. The notices referred to are posted in most golf clubs, and it is hoped that the warning will have the desired effect. This is apt to be a serious accident, as burns, either from heat or chemicals are the most serious of injuries, especially in their remote effects. Until a physician can be seen, the best thing to do is to flood the eye very freely with water.

An alkaline solution, such as salt or soda, is chemically the proper thing to neutralize the acid, but the tears flow abundantly under these circumstances and tend to neutralize the acid. To stop to prepare such a solution is wasting time, and water had better be used at once. It is well to remember that solutions that are warm are much more agreeable to the eye than cold ones, and if warm water is at hand it should be used, as the person will more easily open the eyes than if the water was cold, and the irritating acid will be the more thoroughly removed.

A less well-known game, racquet, is also responsible for eye injuries of a serious character. A small and hard ball is "passed" around an enclosed space by bounding against the walls, and it is not unusual for a player to be struck in the face by the flying ball and seriously hurt. In one well-known racquet club in the East some half dozen members have suffered the loss of an eye. In such a game some protection of the eye is as necessary as in fencing.

Occasionally we meet with another accident to the eye, fortunately not so serious, but very painful. This is the result of scratching the eye of the mother or nurse by the finger-nails of nursing children. One would not think that such an accident was apt to happen often, but when one physician can recall a dozen such, it can hardly be called rare. This injury is extremely painful, but as was said before, not apt to be followed by serious consequences.

There is a class of accidents, now fortunately less common, due to the explosion of fireworks, fire-crackers, toy cannons, etc., which sometimes lead to very grave results. The usual way in which such an accident happens is in investigating the cause of a delayed explosion. The force of the explosion, if it occurs close to the face, can destroy the eyes, but this result is happily not common. The most common result is filling the skin of the face and the membrane covering the eyeballs with the burnt grains of powder. These are difficult to remove, but should be removed if possible. This part of the work must be left to the physician, but the eyes should be washed with water or boric acid solution (a teaspoonful of boric acid to a glass of water), used warm for reasons already stated, and then a cold, wet cloth applied to the eyes.

One is tempted to digress for a moment to say a word of approval for the efforts at the establishment of a safe and sane Fourth of July, which has done so much to decrease the number of accidents such as the one just referred to. If people would exercise more care at other seasons as well in regard to trusting the children with explosives, it would be an equally good thing. Older people fortunately are as a rule more careful.

In their desire to improve their good looks, ladies resort to artifice to make their hair curly, the usual artifice being the well-known curling iron. As manipulations done with the aid of a mirror are done backwards, and therefore more or less awkwardly, it is small wonder that the hot iron is sometimes allowed to touch the eye and burn it. This accident is not at all uncommon, and the knowledge that it is not uncommon should be a warning to users of curling irons to be extremely careful in their manipulations. This is of course the principal thing in regard to this, as of many other injuries, namely, its prevention. In the event that the accident should happen, one can see on looking at the eye a white streak on the clear part of the eye, very easy to see, and broad or narrow, long or short, depending on the extent of the surface with which the iron came in contact. This white substance in the track of the iron is the dead "skin" or top layer of the eye, and is similar to what is seen on the skin when it is burned. It is the very best possible protection to the raw surface underneath, and no attempt should be made to remove it.

A peculiarly distressing accident on account of its severity is the injury to the eye by small shot. When parties of two or more are hunting small game in cover sufficient to hide them, it is extremely easy to forget the exact position of one's partner, and fire in his direction. Shot will enter the skin, but in the body and extremities it produces a slight and superficial injury. If one is so unlucky as to have one or more of the shot strike the eye, the condition is very serious. If the shot travels with sufficient force to penetrate the eyeball, we then have that most serious of eye injuries, viz., a foreign body in the globe. It is well known that magnetic foreign bodies (steel and iron) can be withdrawn from the eye by a powerful magnet, without entering the point of the magnet into the eyeball, but in case the foreign substance is lead, glass, wood or copper, this plan is not possible, and the only way to get such a piece out would be to "fish" for it, with results more disastrous than those occasioned by the original injury. It may be briefly stated that an eye injured by the penetration of a bird-shot into it is usually lost, as far as the sight goes, and often the eyeball has to be removed. It should be impressed on every hunter, therefore, that it is necessary to be extremely careful before he fires his gun, to know that no one is in range. He should insist on the same care on the part of his fellows. One would feel perfectly justified in absolutely refusing to go into the field with a man not willing to exercise this care. Repeated signaling to indicate your position, in spite of its effect on the game, is advisable. A patient, who met with a hunting accident as a result of which he lost his eye, told the writer

that in his old age he had made a new rule of conduct, namely, not to hunt with a deaf man. His companion was so afflicted, and did not hear him call.

A very effective safeguard against such accidents is the use of a protecting glass, something like automobile goggles. These are usually sufficiently large and heavy to cover and protect the whole eye, and to resist the impact of bird-shot. Even should the glass be broken, it is not nearly so likely that the eye will be injured as would be the case if it was not so protected. As many of us wear glasses anyhow, the wearing of them when hunting is no hardship, and to those who do not wear them at other times the protection that they afford from wind, glare and injury from twigs, pieces of grass, etc., while out in the woods or fields, or on the water, makes the use of the so-called "shooting glass" a great comfort. If they are made in amber tint, or the yellow-green color known as "Euphos" glass, they are a greater protection from glare than plain glasses, and interfere less with the sharpness of vision than do the smoked glasses.

The protection afforded by glasses of any sort might seem to be more apparent than real, as in case of an accident the danger to the eye from bits of broken glass would appear to be considerable. Some years ago there was quite a discussion of this matter in one of the medical journals, and very few instances could be collected where the eye was hurt by a piece of broken spectacle lens. We frequently see people who wear glasses meet with accidents in which the glasses are broken, but seldom is the eye itself hurt by the fragments. Indeed, if the glasses are provided with rims they are a protection rather than otherwise. E. C. Ellett has seen a man who was struck in the face with a baseball while wearing glasses, receiving a severe injury to the eye. But while the frame of his glasses was badly bent and the glass over the injured eye was broken, the eyeball was not cut at all, the only damage being a severe bruise. So that one need not hesitate to wear glasses or goggles on account of a fear of receiving an injury through them.

In addition to the protection afforded the eyes from accidents in shooting, goggles of some sort are frequently advisable to guard against lesser accidents and discomfort in motoring. Ordinarily, riding around the city is done at such a pace, thanks to the traffic squad, that the eyes are no more in danger than in walking, but in touring there is much possible discomfort, especially from wind, besides minor accidents from cinders and from insects, that can so easily lead to serious consequences, that every reasonable precaution should be taken to avoid them. Preventive medicine is not very satisfactory in one

respect. One misses an illness or an accident and probably thinks the precautions that saved him were unnecessary and no harm would have befallen him in any event. Nevertheless, in prevention lies the greatest service that the medical profession can render to the race. It is much wiser to adopt precautions, although somewhat troublesome, than to receive an accident which may impair one's sight, and cause, not only pain, suffering, loss of time and expense, but permanent disability, unhappiness and decrease of earning power.

Workers in iron and steel furnish one of the largest groups of industrial eye injuries and the great majority of these occur in men who are engaged in hammering one piece of steel with another or in holding some instrument that another man is striking. The small slivers of steel which are sent flying in this way have an almost incredible power of penetration. Pieces not more than 2 or 3 millimeters in length frequently pass clear through the eyeball and lodge in the tissues behind it. Where the piece of metal is minute, the sense of injury is often so slight that the victim pays little or no attention to it, and later when the effects of the injury become apparent he may not be able to recall having been injured at all. On the other hand, when the metal has a size of 3 to 6 millimeters in length the injured man generally has an exaggerated idea of its size; often stating that he felt as if he had been struck with a fist and consequently he feels sure that the piece must have been a large one, and that it cannot be within the eye. Yet it is of the greatest importance to know that a piece of steel is within the eye, since, if the fact is recognized, the metal can be generally located with the x-ray and can in many cases be extracted with a magnet; while if it is left in the eye it may cause either rapid destruction of the eye by inflammation or, acting more slowly, it may cause blindness through a peculiar degeneration of the retina, which is apt to result from the long-continued presence of steel in the eye.

Next to iron and steel, copper and brass are the most commonly used metals, but injuries caused by them in industrial circles are comparatively rare, both because they are not much used for things that are hammered, and because they are not brittle and apt to send off flying fragments. The most common source of injuries with these metals is the explosion of cartridges, either in the hands of the small boy with a hammer, in blasting operations or in the use of defective firearms. A typical form of injury with copper is caused by the use of high-powered cartridges in small rifles. The breech-closing mechanism of these guns is frequently so weak that the explosion of powerful cartridges displaces it just enough to allow the escape of small fragments of copper. Although these generally fly off at such an

angle that the face is not touched, cases occasionally occur in which an eye is ruined in this way.

In blasting operations, the laborers are injured either by the premature explosion of cartridges with too short fuses, or by delayed explosions; the worker being injured when he goes to find out why the shot has not gone off. In extensive excavations, when a number of cartridges are set off at once, by an electric current, workmen sometimes lose their lives or their sight through misfires. One or two cartridges out of the lot having failed to go off, the workmen having no way of knowing this, go to work with picks to clear away the broken rock, and are greeted with explosions which fill their faces and eyes, and sometimes their entire bodies, with bits of copper or finely divided rock.

An interesting fact in connection with eye injuries from copper or brass is that, although these bodies cannot be removed with the magnet as can the ordinary bits of steel, they have a tendency to work to the surface, so that in quite a large proportion of the cases, if the eye is not so seriously injured that it has to be removed, the copper gradually works out of itself, or shows above the surface a sharp corner which can easily be seized with forceps.

Injuries from lead occur most commonly in the way of shotgun wounds; quail-shooting being particularly dangerous in this respect on account of the low elevation at which the birds fly. Injuries from hammering lead are almost unknown, because the metal is soft, but injuries from melted lead take their place with the large class of burns of the eye from molten metal in general. Such injuries do not, as one might suppose, occur most frequently in foundries, but more often, in proportion to the number of men, in smelting works, where large vessels of melted slag and metal are handled by ignorant and unskilled laborers. One of the commonest ways in which melted metal and slag injure the eye is through its being poured into a vessel containing moisture, or through thrusting some wet instrument into it. The force liberated by the instantaneous development of superheated steam blows the hot metal about in profusion, and many a greenhorn suffers thereby.

All sorts of grinding, polishing and turning instruments are apt to cause eye injuries, but these are generally of a superficial character.

Chemists and chemical students are subject to eye injuries, both from exploding chemicals and from the gas propelled by such explosions. These chemical burns are frequently most disastrous to the sight, and a number of distinguished chemists have lost the use of one or both eyes in this way. The extensive use of concentrated ammonia

under pressure has also led to a number of serious chemical burns. Burns with alkalies, such as ammonia, are often deceptive, in so far as they generally appear, at first, less serious than they really are; the injured cornea retaining its transparency for some time after the tissues have actually been killed to a considerable depth.

Among the chemical burns, injuries from lime, unslaked or only partly slaked, should be included. These chiefly occur to mortar-mixers and plasterers, but occasionally occur to the novice who is tinkering with an old ceiling. It is found that even in old plaster and mortar there is sometimes retained enough chemical activity to cause very destructive effects in the eye. The advice commonly given in the management of these chemical injuries is to use weak acids like vinegar for burns with lye, ammonia and lime, and weak alkalies such as dilute soapsuds for injuries with acids, but there is no use in attempting to produce chemical neutralization. The best means of treatment in these cases is to put the patient on his back and pour plenty of lukewarm water between the well-opened eyelids as quickly as possible. The same advice applies to all injuries in which finely divided foreign bodies, such as sand, ashes, etc., get into the eye. A little salt added to the water, in proportion of an even teaspoonful to the quart, makes it less irritating.

The development of electrical appliances has brought with it two typical forms of eye injury. In one of these the cornea and sometimes the retina of the eye is injured by too close proximity to the intense light of an electric short-circuit. In the other, internal injuries, principally to the crystalline lens, result from the passage through the tissues of a strong electric current. This form of injury is almost a duplicate of that occasionally produced by a stroke of lightning.

Workers engaged in bottling aerated liquors are subject to injuries from broken bottles, when an attempt is made to cork a defective one. Bartenders and others are also occasionally injured, both by flying corks and by pieces of bottles, which occasionally break when the gas in them is suddenly released.

One form of blindness which comes to the modern worker is that which results from drinking wood alcohol or inhaling its fumes. Of course, the numerous deaths and cases of blindness which result every year from drinking this treacherous compound are not incurred in the line of work, but painters who use varnishes or shellacs mixed with wood alcohol, in closed rooms or more especially in painting the inside of beer vats not infrequently fall victims to its poisonous properties. As an example of this danger the citation of the following case may

serve a useful purpose: A painter who was doing a very fine piece of wood graining and was extra conscientious about avoiding any contamination of the fresh surface with dust, closed the room in which he was working for several hours, while he was finishing the job with a varnish mixed with methyl alcohol. Two hours after finishing the work his eyesight failed entirely, and although he finally recovered enough sight to barely find his way about, he remains a county charge. Such cases serve to emphasize the point upon which oculists have been insisting for some years, that all wood alcohol should be marked "Poison! May Cause Blindness if Drunk or Inhaled." As a further protection to workingmen it should be made illegal to manufacture or sell shellac or varnish made up with this poison.

In the broad sense of the word, the largest contingent of the industrial army is made up of agricultural laborers, and in all but the large manufacturing centers the majority of serious eye accidents occurs in this class. As might be expected from the varied activities of the man on a farm, the character of these accidents shows the greatest diversity. These include quite a number of wounds from flying steel occurring while the victims are hammering at their farm machinery. A lot of wire-fence injuries result from running into or from being thrown into the barbs, or perhaps more often from staples flying back when the wires are being taken off of fence posts. A coil of tempered wire is a very treacherous thing. The ends have a way of springing about in an entirely incalculable manner, a fact which every one handling wire should keep in mind. Then come the botanical injuries, of which the typical ones are superficial but ragged wounds of the cornea from blades of corn or beards of wheat, and the more deadly penetration by thorns and weed stubs, which more commonly occur to children. Wood-chopping injuries are also typical and common; the danger to the bystanding child being greater than to the man who wields the ax. Horse and mule kicks furnish a considerable number of the eye injuries on the farm, and this is one of the rare forms of standard eye injury which would generally not be prevented by the use of spectacles. Kicks from cattle rarely injure the eye, on account of the limited vertical displacement of the animals' hoofs.

A fairly numerous list of eye accidents belong to what may be termed household injuries. An enumeration of some of the most typical of these may do some service in the way of prevention. Chips of steel are not infrequently driven into the eye through the attempt of some householder to open a box by driving the hatchet under the lid with a hammer. This combination of hammer and hatchet is particularly deadly, because, on account of the relatively large mass of the

pieces of metal employed, the chips which are broken off the edges fly with great velocity. This danger should be kept in mind, and if it seems necessary to drive a hatchet or ax into a crack, the danger can be averted by interposing a piece of wood between the two surfaces of metal, or by using a heavy stick of wood instead of a hammer. The attempt to drive a nail into a hard plank, on the part of a novice, not infrequently results in the nail flying back so as to injure the eye. Many an eye is lost by the chopper of kindling-wood, one end of the stick struck at right angles being frequently thrown up with great violence. Striking the eye against some projecting corner of furniture while the victim is going about in the dark is a common cause of household eye injury. This is most apt to occur through the patient's stooping over in the dark and bumping his eye on a projecting chair-post. These injuries frequently cause entire loss of sight. Every one going about in the dark should hold the hands six inches or so in front of the eyes. These injuries are also a warning to eliminate sharp corners on tables, as these are of just the right height to put out the eyes of the active child.

Accidents with household chemicals are not uncommon: a bottle of ammonia, or some strong acid, or a can of concentrated lye being spilled into the eyes while being lifted down from some shelf. Even when chemicals are put away tightly corked the cork frequently goes to pieces under their influence, so that after being set away for some time, some of the contents easily escapes when the bottle is slightly tilted. This should lead to the enforcement of a rule requiring all such chemicals to be put on a low shelf, far back out of the reach of little children. Then there is a large line of household accidents to children's eyes resulting from the foolish practice of trusting these innocents with sharp or pointed instruments. Many an eye has been put out by a child attempting to untie a shoestring with a fork, or by falling while carrying knives, scissors or pencils. The mention of these accidents suggests the remedy, and if a little child must be entrusted with a knife, scissors or pointed pencil, even while crossing a room, it should be shown how to carry the dangerous object with the point turned back, so that if it trips and falls the point will not stick into the eye.

A patch of weed stubs about the house is a menace to every little child's eyes. The writer recalls one case in which a child after having fallen into such a patch was brought to him with one eye entirely ruined, and on removing the latter a piece of the weed was found broken off in the tissues behind it.

Toy rifles, air-guns, slingshots, bows and arrows are all a prolific

source of injuries to the eyes of children and should be banned entirely from the list of playthings.

The commonest of all injuries in this group results from getting a cinder into the eye. This form of accident, while seldom causing serious harm, is productive of a very large amount of unnecessary suffering. By proper management a cinder can almost always be gotten rid of by the victim within a few seconds, but, unfortunately, the instinct of self-defense leads most people immediately to do the wrong thing. To shut the eye tightly and rub it vigorously is apt to cause any foreign body with sharp edges to stick, either in the surface of the eyeball or the under surface of the eyelid, and thus at once to furnish occupation for the physician, where, if instead of doing this the victim would take hold of the eyelashes and pull the lid well away from the globe, the flow of tears which always accompanies these accidents, will almost invariably wash the foreign body out at one corner of the conjunctival sac. In the rare cases where this maneuver does not succeed, it is a very simple matter for any one who knows how to evert the upper lid and remove the foreign body with a clean handkerchief. This is a point on which all trainmen should be, and to a certain extent are, instructed. But the knowledge of the proper method of everting the eyelid is a subject which can well be made part of the universal training of the common-school course in physiology.

Prevention of ocular accidents. If one will review the character of the accidents detailed above, a moment's thought will convince him that for the vast majority efficient prophylaxis will be furnished by the use of protective spectacles. It is not overestimating their efficacy to say that by their use ninety-five typical injuries out of 100 could be prevented. Although the workmen know this perfectly well, and although they are constantly being urged by their employers to take such measures of protection, the slight inconvenience attached to their use prevents the great majority of workingmen from employing them. The only remedy for this is a rule making the use of glasses obligatory while working at dangerous trades.

The question of the value of protective glasses is one which deserves to be impressed upon all classes of people. Many people meet the recommendation that protective glasses should be worn, with the counter objection that they are themselves a source of danger, on account of the possibility of their being broken and cutting the eye. This is, of course, a possibility and such accidents occasionally occur, but the insignificance of this danger in proportion to the safety which they confer can be easily demonstrated. In thirty years' experience, during which the writer has seen in the neighborhood of 2,000 serious

accidental injuries to the eye, he has seen only three injuries of any kind caused by broken spectacles. In none of these was the eyesight very seriously injured, while the vast majority of the other injuries to the eye would have been entirely prevented by wearing glasses. Especially where one eye has been destroyed or is so defective as to give insufficient vision for earning a living, should the desirability of constantly wearing glasses be urged upon all classes of people, whether engaged in occupations ordinarily considered dangerous or not. With two good eyes, a man may perhaps be excused for being willing to take the chance of losing one, but where only one good eye is left, the insurance against blindness which even ordinary glasses afford, should not be neglected. By this it is meant that, even if the remaining eye is perfectly serviceable without glasses, prudence dictates that glasses should be worn even by business men and women. Every oculist of much experience has seen those deplorable cases in which a man who has lost one eye, years afterward loses the other, through some insignificant accident which spectacles would surely have prevented. Especially does this apply to children. Every day in this country some dozens, or more probably hundreds, of children lose the sight of one or both eyes through injuries, of which 99 per cent. would have been prevented if the victims had been wearing glasses; and mothers whose hearts are grieved by the counsel of the oculist that their children ought to wear glasses for some defect of vision or refraction, may well take comfort from the thought that their little ones are much less likely to suffer accidental loss of sight than other apparently more favored ones. For men working in hot places, including farmers in summer, one of the chief objections to protective glasses is the fact that they are constantly becoming dimmed by sweat running down from the forehead, and to obviate this inconvenience some frames have been made with a gutter along the top, which catches the sweat and runs it off to the sides.

Besides doing what we can to prevent injuries to the eye by wearing protective glasses and by avoiding the most common forms of activity that lead to eye accidents, much can be done toward the prevention of loss of sight from such injuries, by paying strict attention to the hygiene of the eyes. In a great many cases the injury to the eyesight following an accident, depends not so much on the amount of direct damage done to the tissues, as on the inflammation which results from the wound becoming infected. In the great majority of cases this infection is due to the growth in the eye of germs, carried in from the surface of the eyeball. The germs which do the most damage in this way are the white and yellow pus cocci, which are frequently found all

over the surface of the body as well as in the conjunctival sac, and the pneumococcus, which is a constant inhabitant of most noses and throats and which occurs in the conjunctival sac of a large proportion of normal eyes. It is evident, therefore, that any condition which increases the number of these germs on the surface of the eyeball favors the production of serious inflammations by wounds which often, in themselves, are insignificant. We should therefore not neglect slight inflammations of the conjunctival sac nor of the margins of the lids, but especially should inflammation of the tear sac and stoppage of the tear duct receive careful attention, since otherwise the number of dangerous germs on the surface of the eye is enormously increased. Many people every year pay with the partial or complete loss of an eye for the neglect of an only slightly inconvenient "watering."

It is without the province of this section to discuss the treatment of these wounds and it is only necessary to remind the reader that even in the case of apparently trivial injuries to the eye the prudent thing is to consult, as soon as possible, the nearest available expert in such matters.

WHISKY, TOBACCO, DRUGS AND THE EYE.

While ophthalmologists are familiar with the fact that whisky, tobacco, drugs, etc., are often most injurious to the eyes, this fact is not thoroughly understood by the laity and this article on the conservation of vision would not be complete without a discussion of this important phase of the subject. Edward Jackson, of Denver, Colo., says that to understand how the sight is impaired by whisky, tobacco and certain chemical compounds, one should know something of how poisons act. Most poisons select certain parts of the body, and exert their harmful effects chiefly or wholly on these; while other parts of the body are little or not at all affected. One drug will disturb the action of the heart, while the breathing is not affected. Another will cause the sweat glands to pour forth profuse perspiration, while the glands concerned in digestion are not at all disturbed. So one poison will injure one part of the eye, another will be felt in another part, or in the optic nerve.

Another peculiar thing about poisons is that they affect some persons much more than others. "What is one man's meat is another man's poison," is an old observation. A dose of a certain poison that will kill one person will leave another unharmed. So the eye of one person will be permanently damaged by an amount of poison that is not felt by another. Some people are extremely sensitive to certain poisons, so that a dose that most others will not feel at all may be

dangerous to them. This is called having an "idiosyncrasy" to that substance. Again, the same person may be at one time quite able to withstand a certain dose of a poison, and at another time be seriously affected by a much smaller dose. Substances necessary to life become poisons when taken in excessively large amount; and the most dangerous poisons are harmless, or serve as medicines, when the dose is sufficiently reduced.

Some poisons act severely when taken in large doses, but when taken in repeated smaller doses have no injurious action or produce some quite different effect. For some things the repetition of the dose makes it less and less dangerous. Others only produce their injurious effects when taken for a long time in amounts that were at first not at all felt. These great differences in the action of different substances make it necessary to consider separately the effects that each of them produces on the sight.

Tobacco. One of the most striking and characteristic forms of blindness caused by poisoning is that due to the use of tobacco. So many persons use tobacco whose sight is not affected by it that it was formerly questioned if this could be the cause of blindness. In some countries, as Turkey and Spain, where tobacco has been used extensively this form of blindness is scarcely met with, so that the power of certain races to resist the poison, or some difference in the kind of tobacco used or in the manner of using it, has been supposed to influence its effects. But among the people of North America it is not rare to meet with great impairment of sight unquestionably due to tobacco. This is much more common among men than among women, because of the more general use of tobacco by men; but occasionally women have suffered from it. It generally affects smokers, because most of those who use tobacco smoke. But occasionally one who has only used tobacco by chewing or taking snuff, or has been exposed to it by working with it, as in cigar-making, has developed this condition.

This form of poisoning is one that occurs only after long, habitual exposure to the influence of the poison. Many men are familiar from personal experience with the first poisonous effects of the use of tobacco. The nausea and vomiting caused by a first smoke soon pass away; and on repetition of the smoking they become less, and soon disappear entirely. So far as these effects are concerned, a "tolerance" for tobacco has been established. It is often supposed that tobacco no longer is injurious to that person. But other disturbances even more serious, and liable to be permanent, develop only after the narcotic has been used for long periods. Among these is the partial blindness that it causes.

The patient's age has an important influence in causing such blindness. The great majority of cases occur in men over forty years old. They may have smoked or used tobacco from boyhood and never have had the sight affected by it. They may not at the time be using any more than they have used for years; or may even have reduced the amount as much as one-half before the trouble with seeing begins. Apparently, with age the power of the optic nerve to resist the poison becomes less. This has been ascribed to the well-known influence of tobacco in causing increased blood-pressure. But such a connection is not certain.

Influences that lower the general health often seem to bring on the trouble with sight. It may appear suddenly after a mental shock, or a period of severe nerve-strain, or loss of sleep, or serious trouble with the digestion. When this failure of vision occurs before the age of 40, the general health has mostly been impaired, either by very excessive use of tobacco, or alcoholic stimulants, or by other excesses.

The first thing noticed by a sufferer from tobacco amblyopia is the appearance of a cloud before his eyes, just in the direction he is trying to look. Whenever he looks at a thing this cloud gets in the way. Almost always both eyes are affected, although one may be a little worse than the other. The trouble varies from time to time. The cloud sometimes seems very light and at times so dense that nothing can be seen through it. But on the whole it gradually gets worse and more constant.

From the very beginning the recognition of colors is interfered with, in the affected space. If a large area of color is looked at, like a piece of cloth, a tree, or even a rose held close to the eye, the color may be easily recognized; although a small spot on the colored surface, just where the eye is looking, may appear dull or dirty. When, however, there is only a small point of color, as a flower looked at from a distance, the color cannot be recognized.

This defect of vision is extremely dangerous in those who have to recognize color signals, as engineers, firemen, pilots or sailors on lookout. The engineer or sailor may still be able to perceive a signal light at night. But, seeing no color in it, he will think it is a white light dulled by smoke or fog, or farther away than it really is. Such a person is all the more dangerous because he knows he has always been able to recognize colors, and still recognizes them perfectly when seen in larger surfaces. The power to recognize the signal colors, red and green, may be quite lost before the man realizes that there is anything serious the matter with his sight. This loss of ability to perceive colors might come on in a few days after the eyes had been tested and

the vision for colors found perfect. It has doubtless caused some of the accidents due to failure to obey color signals.

Even after such an accident a man might be tested and judged to see colors perfectly if the test did not include looking at a small point of color, like a signal light. It is in this early stage, when color vision is interfered with, but the patient can still read ordinary type, that tobacco amblyopia is especially dangerous. Safety can only be secured by having each person who has to be guided by color signals understand the danger, and be on the outlook for such an impairment of his color vision whenever his sight seems to be slightly disturbed.

If the disturbance of sight is neglected, and its cause not removed, tobacco amblyopia becomes gradually worse. The impairment of vision is more constant, the spot grows larger, the cloud more and more dense. The patient can no longer read even large print. When looked directly at even the largest letter is not seen; as both eyes are affected, the patient is quite disabled for most occupations. Toward the edge of his field of vision objects may still be seen as clearly as ever. But this kind of seeing is of very little value as a means of working. It may enable the possessor to go about alone and to notice quickly any object coming to him from the side. But for purposes of gaining a livelihood he is practically blind.

When the optic nerve of such a person is looked at, a certain part of it is seen to be unduly pale. If examined with the microscope after death it will be found that a certain part of the nerve is completely atrophied, that is, the nerve fibers that carried the sight impulse to the brain have disappeared and been replaced by scar tissue. It is this tendency to affect certain fibers of the optic nerve, while leaving others quite healthy, that is the special characteristic of the poisonous effect of tobacco on the sight.

To *avoid blindness from tobacco* the first and most important thing is to keep it from entering the system. Many persons can use it, some throughout life, without suffering from tobacco amblyopia. Some cannot; and these must avoid it. Many who have used it without apparent harm in early life cannot safely continue it, or must diminish the amount they use, when they pass middle age. For those who have already begun to notice the disturbance of their sight, the chance of regaining good vision, or even of its not becoming progressively worse, depends principally on giving up the use of tobacco completely, and at once.

Where the sight has been decidedly affected medical treatment may do much to restore it, if commenced soon enough and persisted in. But it is likely to be of very little benefit unless the use of tobacco is

stopped. Other influences that are harmful to the optic nerve must also be avoided; such as the use of alcohol, or excessive nerve-strain from business cares or social indulgences. In many cases strict regulation of diet, and outdoor occupations are necessary to bring about the best result.

For those who use tobacco, but have never felt its harmful effects on vision, moderation is on the side of safety; and especially care to diminish the amount used after the age of forty. Mild tobaccos containing little nicotin are probably less dangerous. The same is true of methods of smoking that cause the least absorption of nicotin, as throwing away the cigar or cigarette before it is smoked to the end. Inhaling the smoke is bad. It is also more dangerous to smoke when the stomach is empty, and absorption likely to be more rapid. As to the amount that can be used without danger of causing amblyopia, no exact rule can be laid down. Among 349 cases observed at the Budapest Eye Clinic, there were very few of the patients who had not used as much as 25 grammes daily, containing about one gramme of nicotin. This would amount to about six ounces of tobacco a week. Other authorities have found that four ounces per week is as much as most persons can use safely; while as little as one ounce a week has caused amblyopia. If we count six cigars to the ounce, about the average, it is clear that three or four cigars a day is the limit of safety for most men; and for a few even this may be very likely to cause loss of sight. If the eyes have once been affected in this way by tobacco, and the disease has been checked and sight recovered more or less completely, the warning should be heeded, the only safe way being to give up entirely the use of tobacco.

Alcohol. There is a whole series of chemical compounds that are called alcohols. The one drunk in whisky, brandy, wine, beer, hard cider, etc., which is commonly meant when simply the word alcohol is used, is grain or ethyl alcohol. Another of the series, methyl alcohol or wood alcohol, is also important as a cause of blindness. But the effects are so different from those of grain alcohol, that it must be considered separately.

Speaking, then, of ordinary ethyl alcohol, its more serious and permanent effects are produced only by its habitual use for long periods. A single indulgence in drinking alcoholic liquors of any kind may produce double vision, or uncertainty of the position of things seen. This is not from the direct effect of alcohol on the eye, but its effect on the nerve centers that control the muscles that move the eyes. These are disturbed in the same way as the nerves and muscles that have to do with standing or walking. The unsteady movements of

the eyes cause uncertainty as to where they are turned, or cause the eyes to turn in different directions, so that double vision results. This passes off with the acute intoxication; but is likely to recur temporarily whenever sufficient alcohol is taken. Some persons are more liable to it than others, as one man cannot walk straight after a single drink, while another is able to keep his equilibrium after taking a much larger amount of alcohol. Occasionally a single large dose of alcohol has been followed by temporary loss of sight, but in these instances the blindness has not often been due to the poisoning by alcohol, but usually to some accident that has occurred in consequence, or something that was taken with the alcohol.

True alcohol amblyopia very closely resembles that caused by tobacco. In the great majority of cases both narcotics act together to cause the injury to the sight. Some think that alcohol is the most important cause; but more cases of weak sight have been observed where tobacco alone was used than where alcohol alone was used. When alcohol is the cause, the sight is liable to be affected rather earlier in life, although but few cases are met with before the age of thirty-five. As with tobacco, men suffer more frequently than women; but only because they more generally expose themselves to this form of poisoning.

As with tobacco the loss of sight begins with a cloud obscuring the object looked at, and vision for colors is lost early. With alcohol, however, there seems more tendency for the cloud to spread to all parts of the field of vision, and for the blindness to be more generally permanent. This may be due to the fact that the general health of the sufferer is more seriously undermined by alcoholic indulgence; and it is more difficult to induce him to abstain completely and permanently.

Prevention of blindness in alcohol poisoning, like prevention of tobacco amblyopia, depends almost wholly on removal of the cause, or the causes, for in most cases both tobacco and alcohol are working together to produce the result. If the use of both be given up before actual disturbance of vision occurs, the danger is entirely removed. If complete abstinence is begun as soon as the clouding of the sight is noticeable, complete recovery will probably occur without any other treatment. But abstinence must be permanent, for when the point of injury to the sight has once been reached, a slight indulgence is likely to bring renewal of the disease, after which abstinence is less certain to prove effective. In most cases of alcohol amblyopia, however, medical treatment to eliminate the poison and bring up the general physical condition to aid in recovery is very important; and generally every

assistance, both medical and moral, is required to maintain the necessary avoidance of the cause.

Methyl alcohol, the so-called wood alcohol, acts very differently from ordinary grain alcohol. Blindness is usually caused by it after a single debauch, in which some mixture containing methyl alcohol has been drunk to the point of insensibility, although the same results may be produced by prolonged exposure to smaller quantities of the poison. It has been said that if ten men drink wood alcohol to insensibility, four will become blind and die, and two will recover, but become permanently blind. The usual course of events is, that after drinking wood alcohol the patient suffers next day from severe nausea and vomiting, often with diarrhea. This may continue for a day or two, during which time vision rapidly declines, or after a few hours' sleep the patient awakes completely blind. Within two days or two weeks some sight returns, and it improves for two or three weeks. Often the patient is again able to go about readily, or even to read. He naturally thinks he is getting well. But without any further poisoning the sight grows worse gradually, and continues to decline until practical or complete and permanent blindness ensues. A full account of this preventable form of blindness is given later in this section.

Tea, coffee, chocolate, and foods. It is well known that these common beverages each contains a substance capable of powerfully affecting the functions of the body, when given in doses materially larger than are contained in the amounts commonly taken. In rare cases, the excessive use of either of these substances has caused a partial blindness. Thus a man accustomed to drinking twelve cups of strong tea daily, had his vision reduced to one-twentieth of the normal. When the tea was stopped, vision improved to two-thirds of normal in about four months. A boy eight years old, who took six or eight cups of strong coffee daily, was found to have less than one-fifth of his normal vision. The coffee was stopped and in eight days his sight had improved to three-fourths of his full vision, which was regained later. A man found that every time he ate chocolate he suffered from an attack of the "dazzles" or ophthalmic migraine. Such cases are examples of rare idiosyncrasy; but being very unusual, the cause of impairment of sight is all the more likely to be overlooked. The discovery and removal of the cause is the one thing necessary to prevent blindness.

Occasionally certain articles of food cause symptoms of poisoning with disturbance of vision, which depend on disturbance of the movements, or the focusing power of the eye. Vision is recovered as the general symptoms of poisoning are relieved.

MEDICINES THAT MAY INJURE THE SIGHT.

Quinin. Of medicinal drugs, which are capable of causing blindness, quinin is the most important. In malarial districts people become accustomed to taking it in very large doses. It is also taken with whisky or afterward, to neutralize the effects of the drinking. Blindness due to quinin begins after the more common symptoms of quinin poisoning have been noticed, ringing in the ears, partial deafness, fullness and aching in the head, dizziness, staggering and even delirium and stupor. It may come on gradually in the course of a few days, or in a few hours, or even quite suddenly. It may amount to only a moderate blurring of vision, but is apt to be absolute—the most complete blindness from which there is any chance of recovery. The brightest light may be entirely unnoticed, although there are usually sensations of flashes of light.

This absolute blindness may last for days, even weeks. But after a time, some sight slowly returns. At first a bright light can be dimly seen when the eyes are turned directly toward it. Slowly this becomes clearer and other objects can be dimly seen when the eyes are turned directly toward them. But the eyes may remain quite blind for things situated aside from the point looked at. In other words, the field of vision is likely to remain narrow, even though the vision may become perfect at the point on which attention is fixed. The patient sees things as though looking through a tube, like a piece of stovepipe; a condition that unfits him for most kinds of useful labor. Nearly always both eyes are affected, at first equally. Later one may recover more sight than the other. In the severe cases there is usually some permanent damage to sight.

Prevention of quinin blindness consists in avoiding excessive doses of the drug. As much as an ounce has been taken at a dose without causing blindness. But half that amount would be very likely to cause blindness. Even quantities as small as 15 grains have, in rare cases, caused some disturbance of vision. Quinin is usually taken in repeated small doses. When this is being done the symptoms of quinin poisoning should be looked for, and when they become more severe, no more should be taken. If quinin blindness arises, medical treatment should be resorted to promptly, and can be expected to restore a large part of the vision. When a person has once suffered from quinin blindness and has recovered, there remains an unusual susceptibility to the drug, so that very moderate doses may bring on a new attack. Such persons must ever afterward use quinin with the greatest caution.

Salicylic acid is sometimes taken in very large doses for rheumatism. It has, in a few cases, caused temporary disturbance of vision, very

closely resembling that caused by quinin, but much less severe. No permanent damage has been observed, and generally recovery was complete within twenty-four hours. The other symptoms produced by salicylic acid, ringing in the ears, dizziness and disturbance, also closely resemble those caused by quinin.

Drugs that dilate the pupil. The best known of these is "belladonna," including all preparations of the plant, atropa belladonna. Others are alkaloids obtained from it; atropin and homatropin, and from other plants of the same family, as datura stramonium, the Jamestown weed or "Jimson weed," and daturin from it; hyoscyamus and its alkaloids, hyoscyamin and hyoscin, also duboisin and scopolamin, similar alkaloids obtained from other members of the same botanical family. These substances all dilate the pupil and paralyze the focusing power of the eye for the time being, and thus make the sight imperfect. The eye is extremely sensitive to their influence. The one-millionth part of a grain of atropin placed in the eye will perceptibly enlarge the pupil. In larger doses its effect may not wholly pass off for two or three weeks.

It sometimes happens that the pupil is dilated and the sight somewhat disturbed from the atropin that reaches the eye when quite small doses are taken into the stomach as medicine, or when a belladonna plaster is worn on the back. This should be borne in mind when medicine is taken internally, and especial care exercised to avoid reading or other close looking that might strain the weakened focusing power. It is sometimes supposed that these drugs have weakened the sight permanently. But no carefully observed case of the kind has been recorded, except where the eye has been previously diseased, in a way that would be aggravated by the use of the drug. When the influence of belladonna, or something of the kind, passes off, the eye returns to its original condition, or generally is somewhat the better for the enforced rest.

Another drug which dilates the pupil, cocain, also prevents the eye from feeling irritation when the surface becomes dried, and the drying of the surface temporarily blurs vision. The effects of cocain, however, all pass off in a few hours. The temporary effects on the sight of some other drugs, as digitalis and aconite, may also be explained by the changes they produce in the pupil.

Drugs that contract the pupil strongly, as eserin, pilocarpin and muscarin (the latter found in toad-stools and putrid fish) may cause dimness of vision, especially at a distance, through cramp of the focusing muscle of the eye. This effect passes off in a very few hours. In a very few cases morphin and heroin have injured the sight.

Male fern. Preparations of the root of male fern (aspidium felix

mas) are quite popular as worm medicines. When one dose has failed to give permanent and complete relief, a second larger dose is taken, and this is sometimes continued until the desired result has been secured. This drug is, however, capable of causing severe poisoning and blindness. Usually the blindness comes on after several hours, or a day or two of severe sickness and vomiting. Sight is lost quite rapidly and in many cases the blindness has been permanent. Such a medicine should be taken only under skilled direction, and if symptoms of poisoning arise, medical assistance should be promptly obtained.

Santonin, another popular worm poison, and the basis of many secret proprietary worm medicines, may also injure the sight. In most cases it has only caused everything to appear a deep yellow tint, as though seen through yellow glass. But in a few cases it has caused complete permanent blindness.

Iodoform, a drug used on raw surfaces, and to control the formation of pus, has sometimes caused poisoning and disturbance of vision. Such effects have only been produced when it was used on a large surface, and for a long time. The disturbance of sight resembles that of tobacco amblyopia. It comes on gradually after other symptoms of iodoform poisoning, such as fever, diarrhea, headache and delirium, have occurred. Removing the cause by stopping the use of iodoform, is generally followed by recovery.

Naphthalene, or *naphthalin* (tar camphor) has long been known to cause cataract when fed to the lower animals. In a few cases where very large amounts have been taken, it has caused partial cataract in man. Potassium chlorate, when taken in very large doses, or used in excess as a gargle, has caused poisoning with impaired sight.

EYE POISONS USED IN THE ARTS.

Lead. Lead is a poison which may gain access to the system in many ways. Commonly these are associated with the occupations pursued, or some special feature in the daily life of the individual. Painters working with lead paint are especially subject to lead poisoning. The wife of a painter, washing each week two pairs of her husband's overalls, became thus affected. Printers handling type suffer from it. Lead in hair dyes has caused it. Tailors and seamstresses, who bite the thread which has been "weighted" with sugar of lead, have been affected. Miners of lead, those who glaze pottery, and workers in lead factories of various kinds, often suffer. Children playing where they handle lead paint, disintegrated by exposure to the weather, especially if they bite their nails or suck their fingers, are liable to take enough lead into the system to cause blindness.

In most cases the disturbances of vision do not appear until the

person has suffered from repeated attacks of lead cramps, colic, constipation, palsy, anemia, and emaciation. But sometimes, especially in children, the loss of sight may be the first symptom, and only very careful observation will show the cause of the trouble. Commonly there is a general haziness of vision, which may rapidly increase to complete blindness. Sometimes the blindness is quite sudden; and from such blindness recovery is usually rapid and often complete. But in the larger number of cases it comes on gradually, the field of vision is contracted and the damage to sight permanent. Prompt recognition of the cause and of the source from which the lead enters the body, with removal of its influence and active medical treatment to remove lead from the system, will generally secure a permanent restoration of vision.

All whose occupations compel them to come in contact with lead should bear in mind the dangers of lead poisoning and consequent loss of sight. Hair dyes, face powders, etc., containing lead should be strictly prohibited. Articles of food containing acids that can dissolve lead should be kept from contact with it. Even the glazing of earthenware may become a source of supply of the poison. Paint containing lead should not be used for places where the hands of children will come in contact with it, especially if it is exposed to the weather, as window sills or porch railings. Those who necessarily come in contact with lead should be careful to cleanse the hands of it on quitting work, and to secure its elimination from the body.

Arsenic is extensively used in the arts, and may be absorbed from wall-paper, insect powder, contaminated anilin dyes, etc., in sufficient quantities to cause symptoms of poisoning, including blindness. The loss of vision generally follows other symptoms of poisoning, as disturbance of the stomach and bowels, irritation of the skin, or inflammation of the nerves and paralysis. The sight is slowly lost with contraction of the field of vision, so that objects can be seen only in a very small space. The progress of such blindness may be checked by finding how arsenic is getting into the system, and stopping it. But the sight lost is not likely to be regained.

Of late years, certain medicines containing large quantities of arsenic, especially atoxyl, which is given very freely as a last resort for sleeping sickness, have caused blindness, which comes on more rapidly. When it was recognized that this caused blindness, and the arsenic was promptly stopped, the sight was sometimes recovered. But where, as sometimes seemed necessary to save life, the drug was continued after the sight got dim, complete and permanent blindness followed. In Professor Koch's investigation of the sleeping sickness in central Africa, of 1,000 treated with atoxyl, 22 became blind.

Nitrobenzol and dinitrobenzol. These drugs, used in making anilin dyes, as a scent, and entering into the composition of explosives, are capable of causing headache, weakness, blueness of the face, and impairment of vision. These symptoms arise among those who work in these substances, especially the grinding of the latter, which gives off dust. Vision diminishes gradually, with contraction of the field of vision and failure of color perception. If the exposure to the poison ceases, as by giving up the work, the sight usually recovers within a few months. Care to prevent the contamination of the air by the dust and to avoid handling of the substances with the bare hands, will prevent this form of poisoning.

Carbon bisulphid is used extensively in vulcanizing rubber. Exposure to the vapor of it causes symptoms of poisoning, including dizziness, irritability, excitement, muscular weakness, mental disturbances and impairment of vision. The disturbance of vision very closely resembles that caused by tobacco and alcohol. If the cause is removed, vision will recover, but not always completely.

Anilin absorbed by those working in it, or used in cosmetics or hair dyes, may cause headache, vertigo, and great disturbance of vision. After removal of the cause with appropriate medical treatment, all the reported cases have recovered.

Exposure to noxious gases, especially carbon monoxid, and those developed by the explosion of dynamite, may cause grave impairment of vision which may be permanent.

Blindness from Columbian spirits and other forms of wood alcohol and how to prevent it. Although under **Columbian spirits,** as well as **Alcohol, Methyl,** in this *Encyclopedia,* and also on a previous page under this heading, this matter is considered, yet that one may elaborate still further the subject of the deleterious influence exerted on the eye by wood alcohol, the views of Casey Wood, of Chicago, Ill., are naturally sought for, as he is, perhaps, the highest authority on this subject to be found in America, and the following material is largely taken from his writings.

Surely the man who wishes well of his country should be interested in preventable diseases. Inevitable evils one bears with greater or less equanimity, but those forms of ill health that are plainly avoidable should be ruthlessly traced to their sources and eradicated.

Hygienic crusades are all the more likely to be successful in America since we have recently experienced a great moral uprising against those deadly agents, adulterated foods and quack medicines. It is no longer respectable or safe for wholesale or retail purveyors of food and drink to substitute for them any poison their fancy dictates.

The demand for articles that are at least what they claim or seem to be has at last become so loud and persistent that no government can afford to ignore it. Now that the sale of spoiled, noxious or adulterated food is beginning to be regarded as a low form of thievery not uncommonly tinged with manslaughter, the common people are likely to come into their own.

Thirty years ago poisoning from wood alcohol, methyl alcohol, wood spirit, methylated spirits, etc., was almost unknown. The disgusting odor and vile taste of this product of the destructive distillation of vegetable fiber was so repugnant to the palate and the nose that one would about as quickly drink crude petroleum. About 1890, however, a comparatively cheap method of "deodorizing" this ill-smelling and vile-tasting liquid was discovered, and under various names, such as "Columbian Spirits," "Purified Wood Alcohol," "Colonial Spirits," "Standard Wood Spirits" (on the Canadian market), "Cologne Spirits," "Union Spirits," "Eagle Spirits," "Green Wood Spirits," etc., this violent poison was put on sale. It was widely and shrewdly advertised and all sorts of virtues were claimed for it, the chief being that it was a cheap and comparatively harmless substitute for ordinary ethyl or grain alcohol. Not only could it be used instead of grain alcohol in making varnishes, liniments, tinctures, hair-dyes, etc., and as a fuel in lamps and stoves, but also at first its poisonous character was denied in toto. This last claim led to its use not only for these purposes, but also in the manufacture of Jamaica ginger, essence of lemon, liniments, alcoholic extracts, cheap whisky and proprietary "remedies"; generally speaking, in those instances in which the manufacturer regarded his business as a means of getting money "honestly" when there was no danger of being found out.

Soon, however, stories of sudden death as well as of total and incurable blindness following the use of this horrible poison began to appear, not only in medical journals, but in the public press. It was not until a wholesale drug firm in Baltimore had been mulcted in heavy damages for attempting to "turn an honest penny" by the use of "deodorized" wood spirit as a substitute for the four-times-as-expensive grain alcohol in the manufacture of Jamaica ginger, that the trade began to take notice."

Later examples of wholesale poisoning began to be reported. Parties of all classes of people—workmen, picknickers, bar-room habitués, Indians, etc.—indulging in cheap whisky and its substitutes died or became blind. Still later, it was found that unfortunate painters, especially shellackers of beer vats, working in confined and unventilated places, were stricken with blindness, and on investigation it was con-

clusively proven that the befouled, rebreathed and methylated atmosphere was responsible for the result. Cheap varnish made with "Columbian Spirits" costing about 50 cents a gallon (grain alcohol is about $2.40 a gallon), had done its deadly work.

In the years 1903-1904 the late Frank Buller, of Montreal, and Casey Wood set about collecting the histories of the cases of poisoning to that date. Doubtless many instances of wood-alcohol poisoning escaped this inquiry, but they found and reported (*Jour. Am. Med. Asso.,* Oct. 1 to 29, 1904) 275 instances of death or blindness (sometimes both) directly traceable to drinking, or inhaling the fumes of "Columbian Spirits" or some other form of "deodorized" wood alcohol. At that time they drew the following conclusions:

Fig. 1.—A Label Used on "Columnian [Columbian] Spirits."
Note how obscure is the warning not to take this poison internally.

1. Methyl, or wood alcohol, in any of its forms, and all methylated preparations as well, are dangerous poisons, menacing both life and eyesight. 2. It is used as an adulterant of, and substitute for, grain alcohol in cheap whisky and other alcoholic beverages, not to mention Jamaica ginger, lemon extract and many other essences and flavoring fluids. 3. Methyl alcohol is largely used in the preparation of many proprietary and patent medicines, witch hazel, domestic liniments, as well as bay rum, cologne water, Florida water and other perfumes. 4. The injury to the eyesight consists chiefly of a destructive inflammation of the optic nerve or of the retina (or both), followed by their atrophy. 5. The symptoms of acute poisoning are disturbances of the stomach more or less severe, accompanied by abdominal pain, general weakness, nausea, vomiting, dizziness, headache, dilated pupils and blindness. If recovery does not occur, there is marked depression of the heart's action, sighing respiration, cold sweats, delirium, unconscious-

ness, coma and death. 6. The blindness affects both eyes and may set in a few hours after the contact with the poison, or it may be delayed for several days. It is generally complete, with a subsequent improvement, and, finally, a relapse into permanent blindness. 7. The diagnosis can hardly be mistaken. Methyl alcohol poisoning presents a picture unlike that of any other intoxication. Acute abdominal distress, followed by blindness, should always awaken suspicion of methyl alcohol poisoning. 8. The prevention of poisoning by this insidious drug can only be brought about by prohibiting (or rendering unprofitable) the sale of "deodorized" wood alcohol in all its forms. The number of deaths may, meantime, be limited by putting all preparations containing wood alcohol on the list of poisons and prosecuting all persons adulterating foods and drinks with it. Labeling it with the notice, "This fluid, taken internally, is likely to produce blindness," will certainly have a deterrent effect. 9. Wood alcohol intoxication is an example of idiosyncrasy. As in the case of several other poisons, some persons are largely immune so far as permanent damage to the body is concerned. If ten persons drink, say, 4 ounces of Columbian spirits within three hours, all will have marked abdominal distress and probably four will die, two of them becoming blind before death. Six will eventually recover, of whom two will be permanently blind. With still larger doses, the proportion of death and blindness will be greater. 10. Poisoning by inhalation of the fumes of wood alcohol generally occurs when the exhalations are mixed with rebreathed air, as in varnishing the interior of beer-vats, closets or small rooms, etc. It is also highly probable that in susceptible subjects repeated or even single wood "alcohol rubs" may produce poisonous symptoms, through absorption of the spirit by the skin. 11. Chronic (or partial) poisoning from wood alcohol (in the shape of "nips" of Jamaica ginger, bay rum or punch made with Columbian spirits, etc.) is the most insidious and probably not an uncommon form of intoxication. Its symptoms are not so pronounced or so easy of recognition as in the acute form, but the eyes, digestive apparatus and nervous system undoubtedly suffer. 12. The use of ethyl or grain alcohol in the arts, as in the manufacture of varnishes, as a burning fluid, for "stiffening" hats, lacquering brass, etc., is without danger to life or eyesight. If a small percentage of naphthalin, for example, were added to it, the fluid would be undrinkable. A combination of ethylic alcohol with 10 per cent. of wood spirit would answer the same purpose. Such a mixture is the "methylated spirits" of Great Britain, where not a single case of acute poisoning or blindness from methyl alcohol is recorded, in spite of the extensive use of methylated preparations in the British Isles. 13. The

treatment of methyl alcohol intoxication consists chiefly in getting rid of the poison from the stomach and intestines by means of the stomach-pump and rectal injections; stimulants, especially ethyl alcohol, strychnin and coffee; heat to the body and extremities. 14. The treatment of the blindness is unsatisfactory.

How wood alcohol acts as a poison. The symptoms of poisoning from wood-alcohol, drunk, inhaled or rubbed in, either as "pure" Columbian Spirits or as common wood-alcohol are as definite as those of measles or whooping-cough, yet the exact manner and the ultimate form in which it destroys or cripples the internal organs are not well understood. We do know, however, that once absorbed, from either

Fig. 2.—Another "Deodorized" Wood-alcohol Poison.
It is recommended for bathing, rubbing and sponging the sick, for making liniments; also for use in chafing dishes and in spirit lamps. See how little is said about its poisonous qualities.

the stomach or the lungs, into the blood, it is not so easily eliminated or burned up as is ethyl alcohol, which it masquerades in commerce.

This peculiarity of methyl alcohol is of considerable importance and interest because, becoming cumulative in the system, small and frequent doses of the poison in the form of quack medicines, hair-tonics, cheap whisky, or essences, rubbing the body after Turkish and other baths, burning in "alcohol" lamps, varnishing pianos, beer-vats, small rooms, etc., insidious and often unsuspected but serious damage to the digestion, sight and nervous system may be induced.

After Columbia Spirits and similar "deodorized" poisons had been in the export market for a few years, we began to hear from other countries where, as in America, until this development of the wood-alcohol industry, poisoning from methylated spirits had been entirely unknown. About the time (the end of 1904) that twenty persons were poisoned in Kentucky, an equal number of wood-alcohol victims were,

within twenty-four hours, killed and blinded in Dorpat, Russia. The Russian physicians were very much interested in and excited by this destruction, but our cases did not disturb us greatly; we had lived too long with the wood-alcohol "trust" for that. It only seemed to us that another infant industry had grown up and had reached a foreign shore. Later on, it will be seen how Columbian Spirits, or a replica of it, has recently invaded another country hitherto free from it.

As a result of these "accidents" a wide-spread agitation against the unrestrained sale of this poison was begun and kept up in both the medical and the lay press of the United States. As a further contribution to this campaign the writers reported several examples of wood-alcohol intoxication which had not been published up to that time, and closed with the following observations on its prevention:

Frank Buller, has suggested that every package, wholesale and retail, of "deodorized" wood alcohol, bear the warning, "This fluid, taken internally, is likely to produce blindness." Such a legend might be even more effective than the word "Poison" and the familiar picture of the skull and cross-bones, chiefly because to most people the fear of blindness is more impressive than that of possible death. No doubt this precaution would limit the dangers of serious poisoning from methylated preparations, but it is very doubtful whether it will ever be entirely effective. Whenever a government permits the manufacture of "deodorized" wood alcohol (as in the case of Columbian Spirits in the United States and of Standard Wood Spirits in Canada) the only effective, natural safeguards (the offensive odor and taste) against ingestion of the poison are removed and the annual sacrifice to death and blindness will certainly continue. Either the manufacture and sale of "deodorized" or "purified" wood alcohol should be absolutely prohibited or, as in Germany and Great Britain, an untaxed (grain) ethyl alcohol, or one rendered undrinkable by the addition of mineral oil, wood spirit, naphthalin, or some other nauseous compound should be allowed for use in the arts in the place of Columbian Spirits and similar dangerous preparations.

The fact that the consumption of millions of gallons of cheap alcohol in other countries has been going on for years without fatal consequences, while in America we have had hundreds of deaths and cases of blindness from the employment of an agent that possesses no advantages over the British Methylated Spirits, or the German Brennspiritus, is surely an unanswerable argument in favor of this proposal.

After a time and partly in consequence of these investigations, but more directly as the result of discussions in the newspapers and of resolutions passed by the Section on Ophthalmology and House of

Delegates of the American Medical Association, several bills were finally introduced into Congress providing for a cheap, commercial, grain alcohol which would render unnecessary and drive out of the market dangerous forms of "deodorized" wood spirit. The success of the movement was largely due to a committee of manufacturers formed to assist in securing cheaper alcohol for industrial purposes, headed by Mr. Henry Dalley of New York. After considerable discussion of the project by Congressional committees and the hearing of much evidence, especially that furnished by a number of workmen blinded by using Columbian Spirits in their ordinary occupations, the bill introduced by the Hon. W. Payne was passed by Congress, June 7, 1906. We now have as a result of this legislation what is known as "denatured alcohol," a harmless grain or ethyl alcohol, rendered unfit for drinking purposes by an admixture of various ingredients that do not destroy its value for domestic consumption and for the purposes of commerce.

Denatured alcohol is as cheap as or cheaper than Columbian Spirits or any other kind of "deodorized" wood-alcohol and can be bought at drug-stores wherever the "deodorized" poisons are or have been on sale. Not only is there no longer the least excuse for the sale of "deodorized" wood spirits but, without doubt, its manufacture should be prohibited by law. Why? Because it serves no purpose that "denatured" alcohol will not serve and because its existence is everywhere and at all times a menace to the public health. It looks, smells and tastes so much like grain alcohol that its very existence must ever be a challenge to life and sight.

Moreover, in spite of all the agitation in the press and the education of the public by other means an immense amount of ignorance exists and, in the nature of things, will continue to exist regarding the poisonous character and legal status of this deadly agent. For example, in commenting on a suit for damages brought by the widow of a poor varnisher, who died from inhaling the poisonous methylated air of a beer-vat in which he had been working, a certain brewer alleged that the denatured alcohol used as a solvent for shellac "spoiled the beer" and was not as good as the "deodorized" product! Instead of being merely mulcted in heavy damages, as was the defendant in the case referred to, it is to be hoped that future criminals of this class may find their way to the penitentiary.

Another example of the ignorance still prevailing among those that ought to be better informed, is the first (or almost the first) cases of wood-alcohol poisoning known in Germany. In that country, as in England, there has, for the past thirty or forty years, existed a cheap,

tax-free commercial alcohol and, in consequence, there never has been room for any form of "deodorized" poison. For the same reason, also, there is not a single authentic report of poisoning in Great Britain. Whether a few barrels of American "deodorized" alcohol found sale in Prussia or whether the product was a local one seems difficult to decide, but shortly after celebrating the Christmas (1911) holiday "with the aid of wine," 161 inmates of a municipal shelter in Berlin became violently ill and seventy-one of them died. The German physicians knew little or nothing about our wide and varied experiences with methyl alcohol poisoning, and attributed the illness to decomposed meat and other causes until an official in the police department found that the schnapps which had formed a portion of the Christmas celebration was largely charged with methyl alcohol. Later, the suspected meat and sausage were found to be harmless, while a post-mortem examination disclosed the presence of methyl alcohol in the stomachs of the victims.

Another example—and many more might be given—of the ignorance of those who ought to know better is seen in the death (March, 1911) of one workman (J. M.) and the total blindness of his fellow workman L., due to inhalation of wood alcohol fumes while varnishing the interior of a beer-vat in a Buffalo brewery. For a short time these "accidents" were attributed by certain officials to the fumes of a charcoal stove!

That cases of death and blindness from "deodorized" wood alcohol are still occurring in America, and that Columbian Spirits and similar poisons are responsible for them and are still extensively sold can easily be demonstrated.

At the 1912 meeting of the American Medical Association, Park Lewis reported that the extent of blindness due to wood-alcohol is everywhere in evidence and the suggestion was made that every retail liquor-dealer in the country be sent a pamphlet acquainting him with the fact that in many cases even a teaspoonful of the drug will cause a man or woman to become sightless. Efforts should also be made to make it illegal to sell wood-alcohol except under the name of "wood poison."

Columbian Spirits and other dangerous forms of "deodorized" or "purified" makes of the wood-alcohol poison are still sold in the drugstores of the United States and Canada. Those who think that poisonous imitations of common or grain alcohol are no longer a menace to the health should inquire at the nearest large drug-shops and at most general country stores.

During the month of August, 1912, Casey Wood purchased a small

quantity of Columbian Spirits at ten of the principal drug-stores in Chicago, at the same time inquiring the price of "denatured" alcohol. The results of this inquiry are set forth in the accompanying report. Among other items of information it will be noticed that four drug-stores placed no "Caution" or "Poison" label on the bottle. The others complied with the law on poisons to the extent of a precautionary notice or label but there was no registration of the name of the purchaser, as there should be in the case of such a violent poison as "deodorized" wood-alcohol. Note, also, that the price of "denatured" alcohol is generally quoted lower than Columbian Spirits. What excuse, then, except ignorance, is there to justify the use of the latter?

No. 1. Columbian Spirits, half pint, 20 cents. Poison label on bottle. This drug-store does not carry denatured alcohol. No. 2. Columbian Spirits, 25 cents a pint. Poison label on bottle. Denatured alcohol 25 cents a quart. No. 3. Columbian Spirits, 25 cents a pint. No poison or caution label of any kind on bottle. Denatured alcohol 25 cents a quart. No. 4. Columbian Spirits, 20 cents a pint. Poison label on bottle. Denatured alcohol 25 cents a quart. No. 5. Columbian Spirits, 30 cents a pint. Poison label on bottle. Denatured alcohol 30 cents a quart. No. 6. This drug-store carried no Columbian Spirits. Wood alcohol 20 cents a pint. They inquired for what purpose the wood alcohol was to be used. Poison label on bottle. Denatured alcohol 20 cents a pint. No. 7. Columbian Spirits, 25 cents a pint. No poison or caution label on bottle. Denatured alcohol 25 cents a quart. No. 8. Columbian Spirits, 25 cents a pint. Poison label on bottle. Denatured alcohol 25 cents a quart. No. 9. Columbian Spirits, 25 cents a pint. "For external use" printed on label. Denatured alcohol 75 cents a gallon. No. 10. Columbian Spirits, 20 cents a pint. No poison or caution label on bottle. Denatured alcohol 25 cents a quart.

Although it is also a poison we have no particular quarrel with ordinary "unpurified" wood-alcohol or wood-spirit. Its vile taste and smell is a sufficient guarantee that nobody will either drink or inhale it to any deleterious extent, as few have been able to do so. For burning lamps, for cleaning brass and woodwork, the common wood alcohol is all right if one does not object to the odor and is unwilling to pay a few cents more for denatured alcohol. It is quite otherwise with Columbian Spirits, Cologne Spirits, Standard Wood Spirits and all the other forms of "deodorized" methyl alcohol. It is to the "pure, refined spirit for domestic use," the "perfect substitute for grain alcohol" (as the labels read) that one objects. That subtle and often unsuspected poison has not only been directly responsible for the fate

of hundreds of blind people but bids fair, under present conditions of sale and manufacture, to kill and blind additional hundreds.

Although for half a century Great Britain, Germany and other European countries have yearly consumed millions of gallons of industrial grain alcohol "denatured" by processes similar to ours, yet not a single instance of death or blindness has been reported from its occasional internal use. This satisfactory result is due not only to dilution of the poison, whose toxic properties are much modified by the large admixture of grain alcohol, but to the fact that it is almost impossible for even the most insensitive lungs and the most hardened stomach to receive and retain enough methyl alcohol in the various denatured products to induce serious consequences. We are consequently justified in asserting that "denatured" alcohol is practically a harmless mixture and may be used for all the purposes, even as a beverage, for those who like it, without producing methyl alcohol blindness or death.

How we may most effectively prevent wood-alcohol poisoning. Whatever occupation, professional or lay, you pursue, your aid in drawing attention to the hidden evils of "deodorized" methyl alcohol and all its preparations will be most valuable if you not only avoid the use of the poison yourself but discourage its employment by your friends, acquaintances and associates. Tell them that we have an equally cheap, commercial substitute—a harmless "denatured" grain alcohol—that answers every purpose, domestic and other, of wood alcohol. Also ask your druggist why he sells the poisonous article when there is a government-authorized grain alcohol that does not expose his customers to the dangers of Columbian Spirits and other forms of wood or methyl alcohol. By thus discouraging the sale and use of "deodorized" and other forms of wood spirit you aid in that campaign of education which is the most effective agent in protecting the public body from one of the most insidious of our drug and food poisons.

TRACHOMA AND THE CONSERVATION OF VISION.

Trachoma is one of the most devastating and the most nearly universal eye diseases known to man. Entire communities sometimes become disabled from its ravages. Its presence prevents the affected individual from passing from one civilized country to another civilized country. For example, the United States prohibits the entry of trachomatous immigrants.

J. A. Stucky, of Lexington, Kentucky, has probably accomplished more for its relief than any one man in America. His accounts of his work amongst the mountaineers of his state will probably give as vivid

a description of this disease and its terrible results, as anything in literature.

In Dr. Stucky's own words we give some of his unique experiences among the trachomatous mountaineers of Kentucky, with the hopes that effective preventive and curative work may be performed, not only in Kentucky, but in every locality where this dreaded disease has secured a foothold.

He says that to his semiannual clinics only those patients come with the most painful forms of the disease—those so diseased as to be practically incapacitated from household or other labor. Of the 374 cases seen at the clinic in September, 1912, 113 had trachoma; 40 per cent. had corneal complications; 25 per cent. had photophobia; 10 per cent. had entropion; 2.5 per cent. had symblepharon; 25 per cent. had impaired vision, ranging anywhere from slightly defective vision to total blindness, all these were sequelæ of the disease.

The trachomatous patients ranged all the way from small children in mothers' arms to old age. Trachoma patients coming into our ports from Europe are quarantined and forbidden citizenship; and yet, of the 114 of these quarantined cases examined by Stucky, on Ellis Is. and in Baltimore, not 0.5 per cent. were comparable in severity to the average of those seen at the clinic in the mountains. Besides the ravages of trachoma, we meet many cases of ear, nose, and throat diseases, and probably more of the natives are afflicted with hookworm disease and its sequelæ than any other two diseases, and until they are relieved of this there is slow and unsatisfactory response to any medical or surgical treatment for any of their diseases.

Dr. A. Von Sholly, representing the New York Board of Health, who was sent by this board to accompany Stucky on one of his visitations, for the purpose of studying conditions clinically and also to make bacteriologic and microscopic examinations in the acute and chronic stages of the disease, says:

The situation in this country, at present, is ludicrous—we take precautions to keep out infected aliens, but cherish—at least do very little to discourage—the spread of trachoma in our midst, and worst of all amongst our oldest "American stock" at that. That trachoma is prevalent in the mountains of eastern Kentucky and in its most destructive form is a deplorable fact, for anyone who goes there, to see. So long as the highways are sewers, the homes and public meeting-places huge cuspidors, and the common wash-basin scantily filled with water and the nearest rag the bathing equipment for the whole family and its guests—not to speak of the common bed, in many instances without

sheets or pillow-slips—one cannot be surprised that typhoid fever, tuberculosis, hookworm and trachoma are rampant.

The solution of the problem of eradicating trachoma in the mountains is neither simple nor easy—it is complicated and hard, but it can be done. The problem can be solved through a threefold agency, under the direction of the State Board of Health and U. S. Bureau of Public Health—this agency to be (1) the medical man, (2) the graduate trained nurse and (3) the schoolteacher. Von Sholly says also:

The solution of the problem is dissipation of ignorance by teaching the laws and rules of hygiene. When the belief of the mountain folk that "sore eyes" and "weak eyes" are a visitation of the Lord, to be endured with resignation, is supplanted by the knowledge of how infection is carried and what personal and family hygiene means, there ought to be no difficulty in rooting out the contagion. Illustrated public talks; illustrated pamphlets of instruction; visits to the homes by a trained nurse and social worker who has gained their confidence; clinics, such as those held at Hindman and Buckhorn, in Knott and Perry counties, which cure the early cases and give relief to those with irreparably damaged cornea, foster confidence in the mountain people toward their advisers.

In appealing for aid and cooperation in this work, Stucky has received the reply from medical men that "it is useless for oculists to attempt the medical and surgical treatment of the disease with any satisfactory results until conditions are changed." In reply to this he asks, who is to change conditions unless it be the medical man, sanitarian and schoolteacher?

With the character of physical and mental "Anglo-Saxon American stock" to deal with in the mountains of Kentucky where trachoma is so prevalent, he feels confident that the disease can be effectually arrested and then eradicated by the methods and system used in the floating ophthalmic hospitals of Egypt, inaugurated by MacCallan.

While we have made no appreciable progress in ascertaining the specific factor in the etiology of the disease, we have made great progress in the treatment. Stucky considers the treatment in certain conditions to be as important as that of virulent ophthalmia, and requires almost as active day and night care and judgment in the use of remedies, irrigations and fomentations.

CARE OF THE GENERAL HEALTH AND THE PRESERVATION OF EYESIGHT.

Amongst the interesting phases of etiology in ocular pathology is the endogenous liberation of various toxins and their effects upon the eye structures.

This is a broad field of investigation and is closely connected with vision conservation, since the subject concerns chiefly the avoidance of improper food and drink, and the regulation of elimination.

H. D. Bruns, of New Orleans, La., has performed much service in investigating and clarifying this important subject, and his writings are responsible for much that has been accepted concerning auto-intoxication and the eye. In abstracting his article it must again be noted that this and preceding matter form part of a popular review of the whole subject of the conservation of eyesight.

The poison of syphilis, if not promptly controlled, affects every part of the eye in a most injurious manner. Disease of the kidneys may injure the retina, the sensitive plate formed by the expansion of the optic or seeing nerve lining the eyeball. Diphtheria often causes paralysis of the eye muscles, either those that turn it about or that which enables it to change its focus. Measles commonly produces an inflammation of the mucous membrane that lines the lids and covers the front of the eyeball (conjunctiva).

There are well authenticated cases in which an eye remained inflamed in spite of all treatment until a bad tooth was drawn, showing a root immersed in pus. Following a bad "cold in the head" the lining membrane of the cavities communicating with the nose, two in the forehead bone beneath the eyebrows and one in each cheek-bone, may become inflamed. Many diseased eyes have been treated in vain until such an infection was discovered and cured.

These are instances of one kind of auto-intoxication. But there are other kinds of self-poisoning. We must realize that the human body is a chemical laboratory. Every tissue (bone, muscle or nerve) and every organ (heart, kidney or liver) is constantly taking out of the blood-stream the substances it needs, changing them greatly and throwing back the matters—valuable or waste products—thus produced. Moreover, there are certain parts, called glands, the special function of which seems to be the production of substances of little or no use to the gland itself, but absolutely necessary to the health of every other part of the body. Life depends on the exact, unfailing performance of this work by every portion of the living body and on the precise correctness of every chemical change or interchange. When we reflect that all these myriad workings may be deranged by reason of some imperfection born in one or the other of the body parts, or by departure from correct habits of living, as in eating, drinking, etc., we must wonder rather that any of us remain in health than that we occasionally fall ill.

The truth seems to be that we are able to get along fairly well, in

spite of occasional derangements, provided that the organs which get rid of the poisonous waste products (lungs, kidneys, bowels, skin) keep in fair running order. By constantly breathing an abundant supply of fresh air, many of the poisonous matters are burnt into harmless substances (ashes) readily removable.

The study of all these minute, complicated changes in our bodies is the province of organic chemistry. This science is as yet in its infancy, but it is doubtless the next great work that is to carry forward the art of medicine on its beneficent way.

There is even now one small corner of this vast dark field in which we begin to see a little light. Evidence accumulates that one important form of auto-intoxication, due to imperfections in the work of the stomach and bowels—gastro-intestinal intoxication—may result in serious consequences to the eye. It is difficult to escape the conviction that during indigestion, or, still commoner, during constipation, something must enter the blood-stream that should not. For in indigestion the chemical changes in our food are not following the course they do in health, and in constipation every opportunity is afforded for fermentation and decomposition, always the work of microbes.

The most familiar instance of the effect of gastro-intestinal derangement on the eyes is found in the well-known ''bilious attack.'' We all know the expression and many of us have had personal experience with the condition. The coated tongue, the bad taste in the mouth, the headache, the languor, the dullness, and the ease with which the symptoms are dispelled by the time-tried calomel and salts leave little doubt that the condition is one of gastro-intestinal intoxication. During the attacks floating spots before the eyes are commonly observed, and the eyes of the sufferer look heavy and red and rebel against too close application to the usual tasks.

Lately, the observation has been reported of actual opaque particles within the eyes of a number of patients suffering with gastro-intestinal intoxication. A boy who complained of headache and vomiting after reading and whose full vision could not be improved with glasses, after regulation of the diet and bowels, improved not only in general health but in sharpness of sight.

We all know that certain articles of diet harmless to the majority of persons are violent gastro-intestinal poisons to a few individuals. Occasionally not only a general attack of ''hives'' follows the eating of shell-fish by a perfectly healthy person, but sometimes great swelling of the lids, intense redness of the eyeballs and a profuse flow of tears result. Patients are reported to have had hemorrhages into the nervous membrane lining the eyeball (the retina), a serious condition,

after eating freely of strawberries and after over-indulgence in peaches. It is quite well established that some cases of red eyelids or of low-grade inflammation of the membrane lining the lids and covering the front of the eyeball (conjunctiva) are associated with constipation and are only to be cured after its removal. Cases of failure of ability to read, because the focusing muscle of the eye had lost its power, have been noted, which recovered only after dieting and the relief of constipation. A distinguished American oculist, working together with an accomplished physiological chemist, has reported a number of cases of grave disease of the eye in which gastro-intestinal intoxication was undoubtedly present and improvement only took place after proper attention to the diet and regulation of the bowels.

Of all diseases of the eye, that known by the name of phlyctenular ophthalmia seems to be most clearly connected with gastro-intestinal intoxication. The disease is characterized by an outbreak of one or more small white pimples, either on the membrane that covers the white of the eye, or on the clear glassy part (cornea) that covers the colored portion (iris), as a watch-glass covers the face of a watch. Most commonly they come along the line where these parts join. Wherever the pimple appears a patch of redness on the part of the eyeball nearest to it is seen. After a short time the pimple becomes a shallow ulcer, just like a fever blister. If the pimple comes on the clear part, the cornea, even at its very edge, there is dread of light and abundant flow of tears. It is a malady of children, who are notoriously disposed to gastric disturbances, especially those pasty, flabby children whose digestions are never of the best, who catch cold easily and who often have running, sore noses; and it is most common in children whose diet and habits are unregulated, who eat all the cheap sweet-stuffs they can, and spend the night in stuffy, close rooms. Among Southern negroes, a people of notably unhygienic habits and surroundings, it is especially severe, and occurs even in old age. Single attacks are usually easily curable by a calomel and castor oil purge and simple local remedies, but the prevention of recurrence is well-nigh impossible, unless the nose and throat can be put in order so as to increase the amount of oxygen taken in, and the diet and all unhygienic habits and conditions be corrected.

It seems, therefore, that for the health of our eyes, as well as for the rest of our bodies, there is much truth in the old injunction: If you wish to be well, keep your head cool, your feet warm and your bowels open, and the strictly modern might add—your teeth clean and your windows up.—(F. A.)

Conserves. (F.) Spectacles or eye-glasses to improve the sight.

Conspicilla. (L.) An obsolete term for spectacles.

Constantinus Africanus. A celebrated monk, who introduced Arabian science, and especially Arabian medicine, into Europe. Born at Carthage in 1018, he traveled very extensively, studied for a long time in the School of the Mosque at Cairo, for a brief period taught in Salerno at the University, and finally retired to the Monastery of Monte Cassino, in Campania (not far from Salerno) where he died in 1085 (1087?). He was a man of enormous influence until the close of the middle ages. Thus, he was called by many mediæval writers "Orientis et Occidentis Doctor." Berthold of Regensburg, in the 13th century, even went so far as to entitle him "The Inventor of Medicine." He translated (to some extent recasting) into mediæval Latin a very large number of works from the Arabic. Among these was a "*Liber de oculis,*" which, though ostensibly a volume of his own composition, was really a translation of various passages from Hunain.

Constantinus will always be remembered by ophthalmologists, because of his invention of the word "cataract." This term occurs for the very first time in history in the title of the 27th chapter of the little book, "*De Oculis,*" just mentioned. The Arabic term was either "ma" (= water) or "al-ma an-nazil fil ain" (= the water that runs down into the eye); the Latin was "suffusio," the Greek, "hypochyma."—(T. H. S.)

Constants of a prism. According to Dennett (Norris and Oliver's *System,* Vol. 2, p. 151), the constants of a prism may be determined with great precision on the table of the *spectrometer,* and there are numbers of instruments for the measurement of angles that are or can be applied to this purpose. As ophthalmologists, however, we thus far have little need of any but the most easily attainable accuracy. We are required to estimate within reasonable limits the prismatic effect of decentred lenses, either spherical or cylindrical, or both, and to determine also the strength and position of a prism on either of whose sides one of the above surfaces has been ground. This leads to the remark that a decentred spherical lens differs in no respect from a sphero-prism; and though there are combinations of prism and cylinder that cannot be obtained by displacement of the cylinder, those that are so obtained are identical with the prism of like degree on whose side has been ground a cylindrical surface.

Constipation. This condition of the digestive apparatus is but one of the many symptoms related indirectly to a number of diseases of the eye—especially those of the uveal tract. Opacities in the vitreous is also one of these and in the treatment of the various forms of

uveitis and its consequences, elimination from the body of morbific material is a most important matter. This subject will be taken up more fully under the caption of **General diseases in their relation to the eye.**

Constitutional diseases and eye symptoms. See the major heading, **General diseases in their relation to the eye.**

Constrictor palpebrarum. (L.) An obsolete term for the orbicularis palpebrarum muscle.

Construction of school-buildings. See **Conservation of vision.**

Contact glass. This device was invented by Fick and improved by Sulzer. It is a shell, made of thin glass, intended to be applied to a cornea affected by irregular astigmatism, thus replacing an irregular by a regularly curved surface. The contact glass conforms to the curve of the cornea, the diameter of the base generally measuring 12 mm. This cap-like arrangement is surrounded by a small marginal ring designed to be applied to the sulcus and so to lift the shell away from the sensitive cornea. The glass is placed upon the cornea after cocainizing the eye, and (physiological) salt, glucose or boric acid solution may be allowed to flow between the glass and the cornea, to protect the delicate tissues beneath. However, even in the most favorable cases the eye will bear the glass but a few hours; yet in some instances, keratoconus for example, an astonishing improvement of sight sometimes follows this treatment. See, also, **Conical cornea.**

Contact goniometer. A goniometer, or instrument for the measurement of angles, in which the adjustments are made by mechanical as distinguished from optical methods.

Contact lens. A thin glass shell, bounded by concentric spherical surfaces, and used for improving the sight in cases of abnormal curvature or opacity of the cornea. See **Contact glass.**

Contact theory. This is a hypothesis to explain the paths of light-conduction in the brain, optic tracts and retina. Cajal (*Die Retina der Wirbelthiere*, 1894, p. 141) is the best known exponent of this "contact theory." He refers to the relations of the conducting apparatus as follows: It may be assumed that the limited and most individualized paths of conduction for the light-impulses within the retina always consist of an entire group of bipolars which transfer their impressions to a single ganglion-cell. The terminal ramification of the ganglion-cell is greatly expanded in comparison with the lower arborizations of the bipolars; it is therefore possible that the ramification of a single ganglion-cell comes in contact with a more or less extended group of bipolar cells and receives from them the trans-

mitted light-impulse. The most extensive paths of conduction, consequently, will be afforded by the diffuse or the multi-stratified ganglion cells to which is probably transmitted the activity from a large number of bipolars. Finally, the object of multiplication of the surfaces of contact, or the horizontal arborizations within the inner plexiform layer, appears to be to render possible a large number of fairly isolated independent paths of conduction within a limited part of the retina. It is evident that were but a single contact stratum present within the inner plexiform layer to receive all the voluminous and extended ramifications contributed by the two factors of the apparatus for nervous conduction (the arborizations of the bipolars and the compressed ramifications of the ganglion-cells), the fairly isolated impulses conveyed from the visual cells would be confused within this stratum to a general impulse, and so the greater part of the distinctness of a perception be lost. See, also, Norris and Oliver's *System,* Vol. 1, p. 314.

Contactus lateralis nervorum opticorum. (L.) Optic chiasm.

Contage. (F.) Contagion.

Continental convention of signs. See **Convention of signs.**

Continuing rays. Phosphorogenic rays. Those light-rays that have the power to excite phosphorescence in certain substances.

Continuous spectrum. An unbroken luminous band of colored light, produced by light refracted through a prism or reflected from a diffraction (q. v.) grating varying in color from point to point, and shading off on both sides of a certain point at which the intensity is a maximum. The point of maximum intensity is shifted toward the violet end of the spectrum as the temperature of the radiating substance is raised.

Contours, Rivalry of visual fields of. A very good exposition of this subject is given by Brohun, translated by Christine Ladd Franklin, in *System of Diseases of the Eye,* Vol. 1, p. 576. He says that in experiments with Hering's *haploscope*—an instrument consisting of a vertical screen upon which at a horizontal distance apart equal to the distance between the two eyes, two points are marked. When this screen is seen in the primary position a number of optical experiments can be made. In this instance the instrument is employed for the determination of *identical points* of the retinas, in which case Brohun has repeatedly used fields of such a character that on one side was represented a black line on a white surface, while on the other side there was no such line. At the same time certain other lines appeared alike on both sides. In these experiments we were able to state that in the first place the black lines presented themselves

in the binocular field exactly as in the second; that is to say, they were not gray, as one might have expected on account of the fact that the corresponding portion of the other retina was at the same

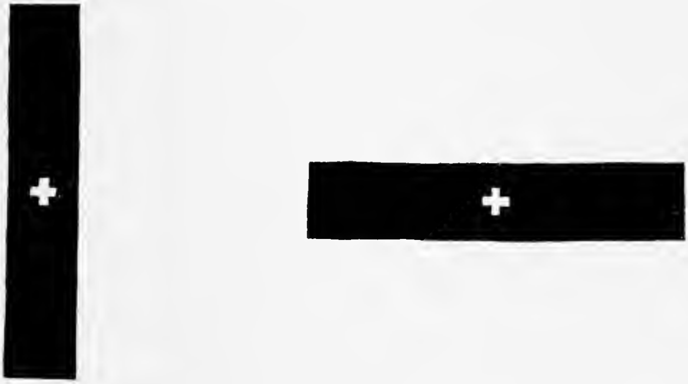


Diagram (A) for Obtaining Union of Two Haploscopic Fields.

moment receiving the sensation of white. If in one haploscopic field we have two large letters, *A* and *B*, and in the other two similar letters, *B* and *C*, and if we unite the two fields in such a way that *B*

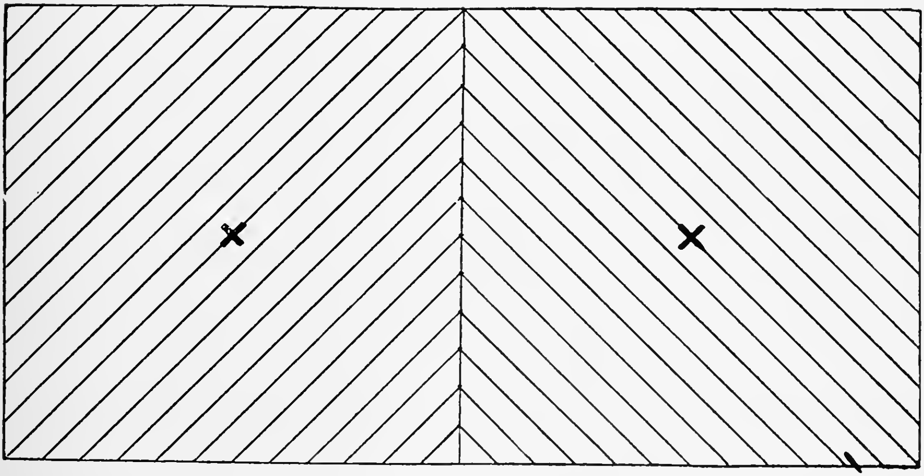


Diagram (B) for Obtaining Union of Two Haploscopic Fields.

falls upon identical parts of the two retinas and is seen single, with *A* on one side of it and *C* on the other, then all three letters look like black on a white ground. If, when reading a book, we hold a sheet of white paper before the left eye, the white ground of the printed

page seems about equally bright whether the left eye is kept open or shut, though in one case the left field of vision is white and in the other it is nearly black, The white paper in front of the left eye produces some effect only if it is brilliantly illuminated, as by the sun. We shall now consider two haploscopic fields containing diagrams which, upon being united, partially coincide with each other. To make the experiment as simple as possible, we choose fields such as those in Diagrams (*A*) and (*B*). In Diagram (*A*) we have on the left a long, rectangular black field perpendicular to the visual plane, and on the right a similar black field situated at right angles to the first. In the middle of each field is a white cross. The fixation-point is kept steady by causing these white crosses to coincide with each other. In the binocular field we have now an appearance which can-

Diagram (C) Illustrating the Effect of the Union of the Two Haploscopic Fields in Diagram (A).

not be very well represented in a drawing, but which, in succession, appears something like what is given in Diagram (*C*), *a, b,* and *c.* (The fixation-crosses are here left out.) At those parts where the contours of one black band overlap those of the other there is a continually wavering appearance, as if there were a constant rivalry between the two impressions which it is possible for the object to convey. This phenomenon has, in fact, been called the *rivalry of the retinas.* The impression obtained is not for a moment that of an evenly black or evenly gray cross. On the parts where the black bands overlap each other, one sees now the contour of one band, now that of the other, and again both at once, as in *b*,—these being so provided that the attention is allowed to wander, and also that (as in our diagram) there is no unlikeness in the intensity of the two fields. This circumstance—that the borders of the two objects make themselves particularly prominent—is called the *rivalry of contours.* Close to an edge one always sees the brightness of that object whose border is for the moment prevailing. The inner square of this figure is always black. Just outside of each contour which prevails there is a white spot which goes gradually into black. If the attention, however, is fixed upon the right-hand band, *a* is the impression which prevails; if it is directed upon the left-hand band, *c* represents what

is seen. In the second case (Diagram *B*) each field contains a series of black lines at equal distances from each other, and inclined at an angle of 45° with the visual plane, running from right to left on one side and from left to right on the other. Upon uniting these haploscopically, we do not see a field of perfect squares, as in (Diagram *D*), but simply notice a wavering image whose separate parts correspond now to the right-hand, now to the left-hand figure. This is the appearance when no particular direction is given to the attention; but if the attention is fixed upon either half of the diagram,— if, *e. g.*, we endeavor to count the lines of one-half, or if we let the visual

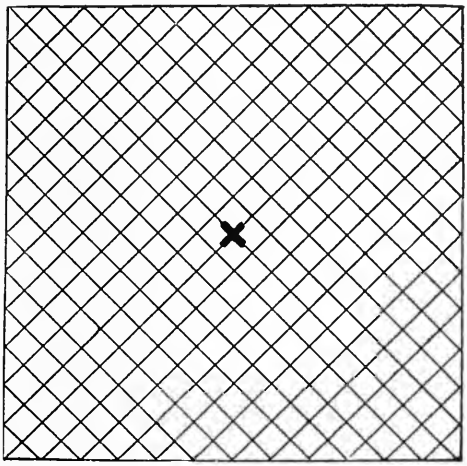


Diagram (D) Illustrating the effect of the Union of the Two Haploscopic Fields in Diagram (B).

regard wander along the lines,—then the half that is regarded distinctly prevails for some moments over the other. Helmholtz explains the rivalry of the visual fields as being due to the wandering of the attention, and finds in the overpowering influence of contours the effect of habit, which leads us to examine especially the contours of any object that is presented to us in order that we may recognize as quickly as possible what the object is. The phenomenon is a proof that the contents of each field of view reach consciousness distinct and separate from those of the other. It also teaches us that such fusion as takes place is not conditioned by the organic structure of the brain. The bearing of the phenomenon upon our powers of perception consists in its showing that when a fusion of the sensations of the two fields does not occur (in accordance with the laws above

explained) in the interests of the perception of a third dimension, each field of vision preserves its independence.

Contracted socket. CICATRICIAL ORBIT. This subject has been referred to on page 2210, Vol. III, of this *Encyclopedia,* and more fully discussed under **Blepharoplasty,** page 1108, Vol. II. In addition to these observations it may be said that L. Weekers (*La Clinique Ophtalm.,* April, 1912) has described a method of deepening a contracted socket, which is simple, and which has given him constantly good results. Supposing the lower cul-de-sac to be obliterated by thick cicatricial bands, these are divided by an incision carried the whole length of the lid about half a centimetre from its free border and parallel with it. Next, a similar incision is made through the skin of the lid, also parallel with its edge and half a centimetre from it. The intervening tissue is now cut through with the knife, so that the lower lid is converted into a bridge, half a centimetre wide, passing from the internal to the external canthus. Finally, near the raw edge of this strip of tissue a row of two or three sutures is inserted; each passes from before backwards through the thickness of the lid and is returned, through the incision, to be tied over a band on the skin surface. These sutures are to be removed after 3 or 4 days. The other raw edge is not dealt with in any way, nor is the skin wound sutured.

If there is only one cicatricial band it is not necessary to cut the whole length of the lid, and a single suture will suffice.

The effect of the sutures placed as described is to approximate the mucous membrane to the skin surface. One would imagine that if tight enough to produce an approximate effect in this direction they would also pucker the skin and thus lead to an unsightly scar. But Weekers says that this is not so, and moreover that he has never failed by this method to get sufficient depth to allow of the wearing of an artificial eye, even in cases where other operative treatment had been tried and given up as hopeless.

The same procedure is applicable to the upper cul-de-sac, the incision in this case passing through the tarsus. It gives good results also in simple effacement of the cul-de-sac without cicatricial contraction.

Contractile collodion. See **Collodion.**

Contraction. CONTRACTION SIGN. In alphabets and print for the blind (q. v.), this term is used to designate a sign standing for two or more letters.

Contraction of the pupil. This act occurs *normally* in response to stimulation of the retina by various agencies, especially by light, and as a result of accommodative efforts. *Abnormal* conditions producing contractions are of greatly varied origin. They include, for ex-

ample, the effects of drugs (eserin, pilocarpin, etc.), and the results of certain diseases or unhealthy states of the nervous system—all of which will be duly considered under various headings, but especially under **Pupil in health and disease.**

Contraction, Two-cell. In alphabets and print for the blind (q. v.), in some cases, a character in Braille immediately preceded by one of the characters formed in the second column of the Braille 2 x 3 area, is used to represent a group of letters, thus using two cells for one contraction.

Contractor pupillæ. SPHINCTER PUPILLÆ. SPHINCTER IRIDIS. MUSCULUS CIRCULARIS IRIDIS. This structure consists of a fairly distinct flat ring of plain, muscular fibres about one millimetre in width, lying next the pupillary margin. It is from 0.07 to 0.1 millimetre thick, and lies behind the vessels against the basilar layer. At its outer edge it is looser in texture, certain fibres arching away from the ring and assuming a radial direction. See **Histology of the eye.**

Contractures of ocular muscles. True primary contractures of the extrinsic ocular muscles are found mostly in hysteria. Secondary contractures happen as the result of paresis or paralysis of the muscle-fibres. The latter form of contracture develops rather frequently and it is developed in the muscles of the sound as well as of the affected eye, the rule being that this form of contracture is mostly the result of efforts to procure and maintain binocular vision. On the other hand, when vision with both eyes together is impossible a healthy muscle may develop a contracture due to the inability of its opponent or opponents to act.

Contra-generic. In *optics,* applied to lenses of the opposite character; thus, for instance, a convex and a concave lens are said to be *contra-generic* lenses.

Contralateral. Occurring on the opposite side. For example, an instance of contralateral atrophy of the optic nerve is reported by Julius Fejer (*Centralbl. f. pkt. Augenheilk.*, Oct., 1912) in which a melano-sarcoma of the choroid broke through the eyeball of a man, aged 58, and spread backwards into the orbit, displacing the atrophic globe upwards and to the medial side. For the last four months the *sight of the other eye* commenced to fail, with contraction of the visual field, especially of the temporal portion. A few weeks after evisceration of the orbit of the affected eye vision in the fellow eye improved. Radiological examination and transillumination showed that the tumor had led to caries of the medial wall of the orbit, produced collateral edema and pressed on the optic nerve, with subsequent degeneration of the decussating fibres. By which path the edema reached the optic nerve of the *other* side, could not be ascertained.

Contrameniscus. A lens, concave on one side and convex on the other, and thinnest in the center, so that its section is of opposite profile to that of the meniscus, which is crescent-shaped. As the concavity exceeds the convexity, the *contrameniscus* is a concave or *diverging lens* and, therefore, of opposite refraction to the meniscus (q. v.), which derives its name from the cusps (points) of the crescent moon. See also **Ophthalmic lenses and prisms.**—(C. F. P.).

Contraplex. Simultaneous transmission in contrary directions.

Contrast. This is a phenomenon excited by fixing colors at the same time and in the same visual field. These subjective sensations are usually described under the term, *contrast.* It is called *simultaneous contrast* in the instance just quoted, while the phenomenon of after-images, for example, is denominated *successive contrast.*

An account of this subject is given by Hess (*Encyklopädie der Augenheilk.*, p. 203). According to him the brightness and color of an object as it appears to the eye are essentially influenced (1) by the state of the retina before incidence of the light rays, as well as (2) by the condition of the neighboring parts of the retina during this stimulation. Phenomena due to the first factor are called *successive contrast.* For example, a gray field seems darker if the retina be previously exposed to bright light, while the same field appears brighter if the retina be previously shielded from light; the field appears green if the retina be previously exposed to red light, etc.

Phenomena due to the second factor mentioned above are known as *simultaneous contrast.* A colorless gray field appears darker on a white background, but brighter on a black background than on a gray background, and again it appears green when seen on a red background, and so forth. Helmholtz and his school explained the phenomena of successive contrast as due to fatigue of the affected portions of the retina. On the other hand, Hering conclusively showed that the explanation of successive contrast as due to fatigue is inadequate. Observations of the brightness of after-images (for example those which appear upon looking at a dark ground after fixating a bright surface), as well as of their changing phases, such as disappearance and reappearance, stand opposed to any theory of fatigue. That phenomena of this sort cannot be explained by the Helmholtz theory can be shown by quantitative investigations; for example, concerning the changes of tone which spectral colors undergo through fatigue of the retina with homogeneous light.

The phenomena of simultaneous contrast are called "deceptions of judgment" by Helmholtz and his school. Hering refuted this view, giving evidence that simultaneous contrast is to be explained physio-

logically,— through changes of the affected portions of the retina. As early as 1878 he wrote: "Upon partial stimulation with light there occurs a reaction not merely of the portion of the retina where the rays fall but also of the surrounding region; the directly stimulated portion suffers an increased dissimilation, while the (indirectly stimulated) surrounding region suffers an increased assimilation, the latter being greatest immediately next to the place directly stimulated and diminishing further away."

Increase and diminution of brightness are subject to definite laws. Quantitative investigations show, for example, the changes which a gray field undergoes when seen on a dark and on a bright background. Measurements of this sort have been made on colorless simultaneous contrasts by Hess and Pectori, and on colors by Cretori and Sachs. The impossibility of reconciling phenomena of this description with Helmholtz's "psychological" theory was demonstrated by Hering by an experiment in which fixing two gray discs on a background made violet by binocular color mixture, the result could be explained according to the psychological hypothesis only under the assumption that a special false judgment is made for each half of the organ of sight.

In most cases of contrast both simultaneous and successive conditions are involved at the same time. In order to shut out the latter, special conditions are necessary; for example, strong fixation or momentary appearance of the examined field. If the experiment be properly arranged, the "subjective" colors called forth by contrast appear quite as distinct and impressive as the "objective" ones, as, for example, colored shadows.

The phenomena of simultaneous contrast are of great importance. In consequence of the manifold imperfections of our dioptric apparatus, especially monochromatic and chromatic aberration, the physical picture of the object on the retina is relatively faulty. Only through the physiological activity of our organ of sight, through which portions lying in the neighborhood of a more brightly-lit area are made darker, and *vice versa*, does the picture become fairly free from the disturbances of aberration and clear vision become possible.

According to Thomson (Norris and Oliver's *System*, Vol. 1, p. 610) this successive contrast plays an important part also in many instances of apparently simultaneous contrast, when one compares colors which are beside each other in the visual field; for it is a fact that in the common use of our eyes we let the point of fixation unconsciously wander in the field, so that it glides successively over the different parts of the object looked at. When, therefore, the eye slowly wanders over an object, an after-image is produced, which, however, as

being only an indistinct spot, is usually not recognized, though an attentive observer will see it. If now the eye look at a neighboring field of another color, of course this color must be changed by the influence of the after-image of the first one. If we place, for instance, upon a sheet of colored paper a small circle of white or gray paper, this will appear in the complementary color. The same principle helps us to understand how the effect of contrast is the greater the nearer the two colors are to each other, because the eye under those circumstances has not time to recover as quickly as it could if the two colors were far apart. We cannot give more examples here, but the results of all the experiments, as Church (*Color,* 1887, p. 102) remarks, confirm in every particular the Young-Helmholtz theory.

With regard to the phenomena of pure simultaneous contrast, however, we cannot make use of the wandering of the eye, because they appear even if the eye is held as steady as possible. Helmholtz regards them as due to deceptions of judgment, because we are inclined to look upon those differences which are distinctly to be observed in the perception as greater than those that are seen only indistinctly in the perception or that have to be judged by the help of memory. A colored field, if looked at steadily, will soon begin to appear gray, and a small square of gray on a surface of green, when covered with a transparent sheet of tissue-paper, appears in a distinct rose red. Helmholtz says, "When in the visual field a special color preponderates, this gradually appears in a whitish shade, while real white then appears in a complementary color. Our mind changes the standard of what we call white." The best example of simultaneous contrast is seen in the colored shadows, especially if the colors are not too saturated. If, for example, a sheet of white paper is illuminated at the same time by day- and candle-light and a pencil be placed on the paper two shades will appear. One is thrown by the daylight, but, being illuminated by the red-yellow light of the candle, appears red-yellow. The other is thrown by the candle and illuminated by the white daylight. It appears blue, complementary to the color of the other shadow. That this blue is produced by an error of judgment the following experiment seems to show. If one looks through a blackened tube on a spot that belongs partly to the white ground, partly to the shadow produced by the candle-light, the second part appears blue. If the tube is now moved so that nothing is seen but the shadow of the candle-light, the whole visual field appears blue, and remains so even if the candle is removed entirely. The blue disappears only if now the tube is taken from the eye. This explanation of these

phenomena of pure simultaneous contrast by errors of judgment has often been objected to, and indeed it seems to be insufficient, though the psychical factor cannot be denied. It is this class of subjective colors that has given such prominence to a new theory of color-perception, that of Hering. A long time before Hering, Plateau had attempted to explain these colors on the assumption that the light on one part of the retina produced an indirect effect on the adjacent parts, a kind of antagonistic activity of the retina that gave rise to the complementary colors. But though on such a theory it is difficult to explain how the gray circle on the green paper appears in a more distinct rose red when the green color is made more indistinct by the tissue-paper, still nothing hinders us from assuming such a spreading activity also among the Young-Helmholtz color-sensitive terminals in the retina, if decisive experiments oblige us to take such a stand. That would in no way affect the Young-Helmholtz theory, but would only oblige us to accept Plateau's principle. See, also, **Color contrast.**

Contrastfarben. (G.). Contrast colors.

Contrasting images. In the examination of the muscular apparatus for the detection of heterophoria, the artificial induction of diplopia is one of our most useful methods. As Stevens (Norris and Oliver's *System,* Vol. 2, p. 174) points out, a less uniform and less useful method is that of *inducing contrasting images* in the two eyes. The simplest method of inducing double images is by the use of a prism. "The principle governing the use of prisms for determining heterophoria, *but not the definite method,* is as follows: If a prism of certain length is held before one eye with its base directly up or down, double images will result; and on the theory of the passivity of the eye-muscles under such circumstances, if there exists no tendency of the visual lines to drift inward or outward, the images will be in an exact vertical line, provided that the object of regard is removed to a suitable distance from the eyes. This distance should be at least twenty feet. *No just appreciation of the muscular balance can be arrived at while the accommodation is considerably exercised or while convergence is required.* If in such suitably conducted experiments the images deviate from a vertical line, heterophoria is assumed, and its manifest extent is measured by a prism, placed with its base out or in, which will bring the images to a vertical line. If in this experiment the image seen by the right eye should drift to the right side (homonymously), esophoria would be indicated; if to the left (heteronymously) exophoria would be shown."

Contre-fracture. *(F.)* A fracture taking place either alone or at the same time as another, in a different situation to the spot injured; fracture by contrecoup.

Contre-poison. *(F.)* Antidote.

Control-experiment. An experiment consisting in the repetition of a previous experiment, the conditions being changed in some particular so as to prove the validity of the inference drawn from the first experiment.

Controlled reading. A test for binocular vision, as well as a method for the treatment of defects of the fusion-faculty. A rough and ready method is to interpose a pencil between the eyes and the book; reading can then take place without interruptions only by using both eyes. See **Bar-reading,** as well as **Diaphragm test.**

Contusio bulbi. BRUISE OF THE EYEBALL. CONTUSION OF THE EYEBALL. CONTUSION OF THE GLOBE WITHOUT RUPTURE. The most varied lesions, extra- and intraocular, may result from blunt injuries of the eyeball. These lesions are fairly characteristic, and are suffusions of blood under the skin of the lids and conjunctiva; perhaps also anterior displacement of the globe from hemorrhage into the orbital tissues; pericorneal injection; opacification of the cornea; wide and immobile pupil; blood in the anterior chamber and vitreous.

The patient complains of poor sight, pain, photophobia and lachrymation. The vision deteriorates and as a rule loss of accommodation with loss of intra-ocular tension occurs. The lesions that may occur from contusions without rupture, are as follows: Parenchymatous opacity of the cornea; hyphema; dialysis of iris; aniridia; partial or total inversion; radial tears; pigmented dehiscences; mydriasis or myosis; cramp or paralysis of accommodation; bleeding; hemorrhagic detachment of choroid or rupture; complete or partial rupture of the zonule, with changes in position of lens, then rupture of the capsule with cataract following; point-like pigment deposits in the capsule; vitreous bleeding and membrane formation; increase and decrease in the intra-ocular tension from the resultant glaucoma or degenerative changes; bleeding; detachment and rupture of retina; Berlin's edema; changes at the macula; bleeding into the nerve sheaths; opticus laceration with rupture and tearing out of the retina. All of these lesions will be found specifically described under appropriate titles in these pages.—(H. V. W.) See, also, **Injuries of the eye.**

A few results of "blunt" injury or contusion of the globe are, *e. g.*, reported by Lagrange (*Arch. d'Ophtal.*, 30, p. 269. *Ann. of Ophth.*, 19, p. 283), who observed a rupture of the choroid on the temporal side

of the macula from a blow on the sclera immediately adjacent to the nasal limbus. He thinks that the case illustrates Arlt's theory that a circle of depression (equator) is produced perpendicular to the direction of the acting force, and that the rupture occurs on this circle. Wittmer (*Arch. f. Augenheilk.*, 68, p. 81) records the case of a man in whom a blow on the eye from a stone resulted in three linear rents in the choroid, temporal from and concentric with the margin of the disk. In De Lavigerie's case (*La Clin. Ophtal.*, 16, p. 65. *Ann. of Ophth.*, 19, p. 828) a contusion of the eye caused mydriasis without paralysis of accommodation, and a rupture of the choroid not involving the retina, as was evident from the perfect restoration of vision. Boulai (*La Clin. Ophtal.*, 16, p. 172) reports three cases of optic neuritis following a severe contusion, without demonstrable lesion to the anterior part of the eye. There was a great similarity between these cases and optic neuritis caused by vascular hypertension due to a variety of causes, such as alcohol, infectious diseases, etc.

The most remarkable result of eyeball contusion is the Vossius anterior ring opacity of the crystalline lens, already described on page 1769, Vol. III of this *Encyclopedia*. The subject is further discussed here, and some additional cases quoted.

Hescheler (*Klin. Monatsbl. f. Augenheilk.*, April, 1910, p. 443) observed a case of ring form opacity of the lens following a severe contusion, with a large hemorrhage into the anterior chamber. The lens also presented several peripheral opacities, but all the opacities finally disappeared. Nicolai (*Arch. f. Augenheilk.*, 67, p. 243) reports the case of a cavalryman in whom a blow on the eye from a saddle stirrup produced hemorrhage into the anterior chamber and ring-shaped clouding of the anterior surface of the lens, which disappeared in the course of a few days. (In Gifford's case [*Ophthal. Rec.*, 19, p. 412] the ring-shaped opacity was due to a glancing blow on the eyeball from a piece of dynamite cap.) Steiner (*Klin. Monatsbl. f. Augenheilk.*, Jan., 1910, p. 60) observed a typical instance of such opacity following a bullet wound of the orbit. This case, in which the force acted from behind and not on the cornea, throws light on the mechanism of such opacities. One opinion assumes that the cornea is forced directly backward on the iris, while the other regards increased tension in the aqueous humor as the efficient cause. Of direct action by the cornea there can be no question in this case, but the heightened tension acting from behind causes sudden advancement of the lens.

In Chambers' case (*Arch. of Ophth.*, 1910, 39, p. 142 and 149), four years after contusion the lens was found to wander between the anterior chamber and the vitreous, according to the position of the patient.

It was removed from the anterior chamber after transfixation with a bident. In Emerson's case (*Arch. of Ophth.,* 1910, 39, p. 145) the traumatic dislocation was hidden by the upper lid.

In Tertsch's case (*Zeitschr. f. Augenheilk.,* 1910, 24, p. 83), besides evidence of contusion of the anterior portion of the globe, there were hemorrhage into the vitreous with diminished tension, and a fundus strongly suggestive of obstruction of the central artery, including the cherry red spot at the macula. The reporter is in doubt whether these appearances were due to dilaceration of a posterior ciliary artery, or to a hemorrhage into the sheaths of the optic nerve compressing the central vessels. In Stoewer's case (*Klin. Monatsbl. f. Augenheilk.,* May, 1910, p. 559. *Ophthalmology,* 7, p. 160, 1910) bilateral retinal hemorrhages of venous origin, with edema, followed traumatic compression of the thorax. The left eye recovered. The right nerve atrophied. Kunst (*Centralbl. f. prakt. Augenheilk.,* June, 1910, p. 164) observed atrophy of the optic nerve follow simple contusion of the globe—apparently an exceedingly rare occurrence. Grandclément (*La Clin. Ophtal.,* 16, p. 555) reports acute glaucoma with hemorrhage into the vitreous in a young man, after a blow on the eye by a champagne cork. Eserin and pilocarpin effected a cure. A rare lesion of the eye is recorded by Borel (*Recueil d'Ophtal.,* 32, p. 293). The patient's eye received at a distance of 2 meters the column of water from the hose of a fire engine. The conjunctiva was completely dissected back from the corneal limbus, and the eyeball was protruded by the pressure of the water forced beneath the conjunctiva into the orbit. The conjunctiva was sutured and healed into its normal position.

In Perrod's case (*Ann. di Ottal.,* 39, p. 693) a reniform pupil with dialysis of the iris and paralysis of accommodation followed a severe contusion. Delicate traces of iris tissue bridged the site of the dialysis. Transillumination was not effective at this point. Hirschberg (*Centralbl. f. prakt. Augenheilk.,* Nov., 1910, p. 328) observed temporary dialysis of the iris, hemorrhage into the anterior chamber, and abrasion of the cornea, from a shot which had ricochetted from the ground. Vision after two weeks was 5/5. Cannas (*Ann. di Ottal.,* 39, p. 172) reports a case of iridodialysis and diastasis involving about one-quarter of the corneal circumference, due to a severe blow on the eye; vision equalled 1/8 with dazzling and diplopia; full vision was had with the stenopaic slit. The following operative procedure was adopted: A conjunctival bridge 6 mm. wide was formed between the limbus and canthus; a scleral incision was made beneath this about 5 mm. long and 1.5 mm. from the cornea. The base of the detached

iris was pulled between the lips of the scleral wound and a suture on two fine needles was carried through the iris and conjunctival bridge and carefully tied across the latter. The final result was a practically normal pupil. In Molesworth's case (*Brit. Med. Jour.*, 1, 1910, p. 200) of iridodialysis from contusion, the fundus was clearly visible through the gap, but complete healing resulted from treatment by full dilatation of the pupil. Maruo (*Klin. Monatsbl. f. Augenheilk.*, Jan., 1910, p. 69) observed a typical sarcoma involving the whole of the superior rectus after a contusion of the upper half of the upper lid—a rare condition certainly as regards incidence, seat and etiology.

Zander (*Zeitschr. f. Augenheilk.*, 1910, 23, p. 82) reports a medicolegal case where damages were sought for what was found to be a Morgagnian cataract, and in which the alleged injury could only have been a contusion of the eyeball. Fine irregularities of the pupillary margin lent some additional probability to such an etiology. The sideroscope and X-ray were negative as regards the presence of a foreign body in the eye. A German tribunal allowed the claim. Wendt (*Zeitschr. f. Augenheilk.*, 1910, 23, p. 266) reports a case of traumatic glaucoma after contusion, followed by recovery after two adjacent wide iridectomies, with high persistent traumatic astigmatism and normal tension. There was localized peripheral retinitis pigmentosa below. He also removed two slivers of steel, the first weighing 0.05 gm., the second 15 gm., from the vitreous with Hirschberg's hand magnet. In both cases retinal cicatrices developed with sector defects in the visual fields. The eyes were otherwise normal and retained relatively good vision. In another case a small sliver of steel was embedded in the posterior wall for nine years without siderosis bulbi. There was a sector defect of the field, but vision was good.

Chevallereau (*Ann. d'Ocul.*, 1910, 143, p. 387) observed four cases of pigment spots resembling syphilitic chorioretinitis after severe traumatism. The spots were uniformly seated in the inferior portion of the retina, although the traumatism had affected the upper part of the globe. They underwent no appreciable modification even after many years. In Kerry's first case (*Ophthalmology*, 6, p. 637, 1910) of severe contusion, almost the entire cornea was stained a rusty red color, which cleared almost entirely after a lapse of fifteen months. Iridodialysis was also present. In the second case a contusion caused hemorrhage from one of the long ciliary arteries between the lens and vitreous. In both of the above the vision finally became satisfactory. In a third case of destructive injury the patient maintained that he could see light, although the tests for the same were decidedly negative. Examination of the eye after enucleation showed that there

was practically nothing left of the retina and uveal tract but a few fibres. (*Ophthalmic Year Book*, 1911, p. 275.)

Once more referring to the subject of the peculiar lens-ring or anterior capsule cataract of Vossius, J. B. Lawford (*Ophthalmic Review*, Jan., 1910) gives the following excellent review of this lesion as furnished by Caspar and Höeg (*Klin. Monatsbl. f. Augenheilk.*, June, 1909). In the year 1903 Vossius described two cases of injury to the eye in which he found a ring of slight opacity concentric with the pupillary margin situated on or close to the anterior surface of the crystalline lens; during the two succeeding years he observed and published several cases. The condition had not been previously described. In 1906 Vossius's cases—six in number—were embodied in a thesis by Keller, who gave a full and careful description of the clinical appearances and a report of Vossius's views as to the nature of the changes. Since Keller's paper was published, six more cases have been reported by various observers, and now Höeg publishes the notes of another case occurring in Bjerrum's clinic, in which he is an assistant. Caspar also reports a case which is important in relation to the immediate causation of the changes in the lens.

Thirteen examples have thus been published and the description in all of them is very similar and fairly typical. The lesion appears to be rare or at least rarely observed, and in all instances has followed a severe blow on the eyeball; other lesions of the eye have resulted in several of the cases, *e. g.*, rupture of iris, or of choroid, but they apparently bear no casual relation to the condition first noted by Vossius. See **Cataract, Vossius' Annular.**

After such an injury, examination of the eye reveals in the centre of the anterior surface of the lens and concentric with the margin of the pupil a delicate, regularly circular opacity with a diameter of 3 to 4 mm. It is always seen most distinctly by transmitted light and then has a rather dark appearance; by focal illumination it is often scarcely recognizable or shows only as an exceedingly delicate grey circle; occasionally it has a brownish color or else the grey opacity is speckled with brown particles and is then more easily seen. On more careful examination with a magnifier exceeding fine dots and streaks are visible. The periphery of the circle is sharply defined, the inner border less so. The area enclosed by the ring is sometimes slightly blurred and the appearance is then that of a disc-shaped opacity with a denser periphery. The circle is nearly always complete and regular, but in one instance, only a semi-circle could be detected, and in two or three others there was an incomplete gap in the ring.

How soon after the injury the lenticular changes can be seen is still uncertain; they have been present at the first examination of the eye, and have not increased in degree. The shortest interval between the injury and the discovery of the annular opacity has been one of "several" hours. After remaining unchanged for a period which is very variable the lenticular changes become less and less noticeable and, in most cases certainly, and in all cases probably, disappear entirely. As a rule the ring begins to fade within a day or two, but in some instances has shown no diminution for 6 to 18 days. Its complete disappearance may not occur for several weeks.

The acuity of vision is apparently unaffected by the lenticular lesion: in several cases it was quite normal, while in those with diminished acuity other damage to the eye fully explained the loss. The changes in the lens are, as a rule, not the only result of the blow upon the eye. In nearly all the cases there was also hemorrhage into the anterior chamber and often a superficial or deep wound of the cornea, while in a considerable proportion rupture of iris or choroid and damage to other structures occurred. The nature of the injury varied, but it was generally a slight or moderately severe contusion; no conclusion can be drawn from this however as such slight changes may occur in severe injuries and be easily overlooked.

What is the exact nature of the annular opacity in the lens? Vossius expressed the opinion that it was an impress of the pupillary margin on the anterior lens capsule: the brownish appearance he considered as a cast of the iris margin and its pigment on the lens capsule by fibrin. The grey opacity he thought was due to degenerative changes in the subcapsular epithelium or in the most superficial layers of lens fibres, induced by the pressure of the edge of the iris. Similar changes have been produced by Schirmer in experimental contusions of the lens, and microscopic examination has shown degenerative changes in the subcapsular epithelium, and when the contusion was severe, slight superficial changes in the lens fibres.

Höeg is in agreement with Vossius and other observers as to the nature of the changes seen on the surface of the lens in the cases under discussion, but he thinks that the explanation that the iris is squeezed between the lens and the incurved cornea at the time of the injury, is incorrect. He believes that the pressing of the pupillary portion of the iris against the lens capsule is effected by a sudden increase of pressure in the anterior chamber brought about by the blow upon the eyeball.

Caspar publishes brief notes of a case recently under his observation because it appeared to him to demonstrate unusually well the production of the lenticular changes by pressure of the pupillary

margin of the iris against the anterior surface of the lens. His patient was struck on the eye by a nail an hour before Caspar saw her. There was a perforating wound of the cornea with prolapse of iris in the lower-outer part. The anterior chamber was filled with blood. In the course of several days the blood became absorbed and examination with a loupe revealed the changes on the lens surface described by Vossius. The changes did not, as usual, form a complete circle but had an egg-shaped contour with a gap in the lower-outer part corresponding to the defect in the pupil caused by the prolapse of the iris. The opacity in the lens had entirely disappeared on the tenth day after the injury.

The ovoid shape of the opacity, the narrow end of which was situated behind the deformity in the iris, and the break in its continuity at this part seem to show clearly the relation of pressure by the iris to the changes on the surface of the lens.

Contusion. An injury caused by a blow from a blunt instrument; a bruise.

Contusion dell'occhio. (It.) Contusion or bruise of the eyeball.

Conus. Crescentric conus. Posterior staphyloma. Congenital conus. Fuchs' coloboma. A crescentric patch seen around or on one or other side of the (optic) papilla, usually the temporal. It consists of a thinning or atrophy of the choroid stroma, including the pigment, which allows the white sclera to become visible.

Although this term commonly refers to the well-known appearance at the optic disc, due to myopia, yet it must be remembered that the word is sometimes employed for *congenital crescent;* it is also known as *inferior crescent.*

Parsons (*Pathology of the Eye,* Vol. 3, p. 840) says that "in this latter condition the disc, often unduly small, is horizontally oval, the lower limit being rectilinear, separating it from a white crescentric area. The cone may be irregular, triangular, rarely vertically oval. The physiological cup is often directed downwards, the neighboring part of the fundus may be poor in pigment (Szili). Liebreich (1859) first conjectured a possible connection with choroidal coloboma. Jaeger (1861) considered that the inferior crescent was due to defective closure of the fetal cleft, and this idea was adopted by Schnabel (1874). Both Jaeger and Schnabel described congenital crescents on the temporal side in the new-born and in high hypermetropes. Fuchs (1882) laid still further stress upon the necessity for distinguishing between the congenital crescents and the acquired, which were due to myopic choroidal atrophy. He pointed out the frequency of errors of refraction and very defective vision. Wollenberg (1889) empha-

sized strongly the occurrence of inferior crescents in the insane. He found them in 1.3 per cent. of insane patients, as opposed to 0.9 per cent. of eye patients (Vossius). The difference is not sufficient to base any revolutionary principle upon, though it is noteworthy that the percentage is increased to 4.7 in congenital psychoses. (hysteria, idiocy, epilepsy). Elschnig (1900) examined 481 eyes—75 emmetropic, 202 hypermetropic, 204 myopic—and found temporal crescent in 217, inferior in 25, nasal in 19, superior in 2; he found temporal coloboma in 9, inferior in 14, superior in 1: by far the most of these anomalies were in myopic eyes. Elschnig's differentiation of conus and coloboma must be borne in mind in considering these statistics (*v. infra*). Vossius found the congenital crescent situated as follows in 111 cases: below, 75 (67 per cent.); down and in, 8 (7.3 per cent.); in, 9 (8.1 per cent.); up, 5 (4.5 per cent.); up and out, 8 (7.2 per cent.); down and out, 6 (5.4 per cent.). Elschnig distinguishes between a conus and a coloboma. The principal criterion is the level of the crescent: if the white area near the disc is at the same level as the disc, it is a conus; if it is ectatic, it is a coloboma. On the other hand, the absence of ectasia does not eliminate the possibility of a coloboma. Inferior crescent has been seen accompanied with typical choroidal and also macular coloboma. Salzmann (1893) made the first anatomical examination of an inferior crescent, though it had not been seen ophthalmoscopically. The pigment epithelium and the inner layers of the choroid were absent, whilst the retina was duplicated, the outer layer being scarcely recognizable. The inner layer showed defective development of the outer retinal layers. The author regarded the condition as a feebly developed coloboma of the choroid. Elschnig doubts whether Salzmann's case was a true conus. He examined 22 cases of temporal or infero-temporal crescents (1901), as well as 5 colobomata at the disc, 1 inferior conus, and 1 internal conus, a condition not previously described (1900). The inferior conus nearly resembles the temporal conus of myopic eyes. The membrana vitrea and pigment epithelium are retracted from the edge of the disc so as to leave the sclerotic exposed, covered only by rudimentary choroid: there is peculiarly little 'intermediate tissue' in the inferior conus. A difference is seen in the distension of the vaginal space on the side of the inferior crescent, and the sclera, choroid and retina are all thinned. Elschnig concludes that inferior conus and probably coloboma and crescents in other directions are not to be explained as remnants of the fetal cleft. They are the expression of stretching of the membrane of the eye, due to defective development: already during fetal

life equilibrium between the elasticity of the membranes and the intra-ocular pressure is probably attained, but may be subject to change in extra-uterine life. The abnormal expansibility of the wall is due to maldevelopment because the relative thinning is too great to be accounted for by the degree of stretching. The frequency of the anomaly in the lower part is determined by the position of the fetal cleft, but all types of conus and coloboma of the optic nerve are caused by abnormal outgrowth of the lips of the secondary optic vesicle in the fetal cleft or at the margin of the disc, inducing defective development in the mesoblastic tissue which gives rise to the choroid and sclerotic. Elschnig is inclined to attribute all crescents, including myopic, to congenital defects which become intensified subsequently.''

The true *myopic crescent,* however, as Parsons (*Pathology of the Eye,* Vol. 3, p. 909) points out, is usually situated on the temporal side of the disc and varies in breadth and in appearance. ''It is generally white, with a sharp edge, often pigmented, towards the normal fundus. In many cases only the part near the disc is white, the peripheral part being yellow or brownish red with choroidal vessels visible upon it. The crescent may be very narrow or one to two papilla diameters in breadth; in the latter case it extends farther round the disc and may form a ring. In some cases the floor is demonstrably below the level of the surrounding fundus, and for these the term 'conus' might be reserved, though there is probably no fundamental difference in nature or structure. The crescent was early, and is often now, included in the term 'posterior staphyloma'; this name should be reserved, however, for the ectasia of the posterior pole, of which the crescent is usually though perhaps not necessarily, a concomitant. The crescent is by no means confined to myopic eyes, though it is far more common in them than in emmetropic or hypermetropic; it was described in the latter by Seggel. Donders found it almost without exception from 16 to 20 years of age in myopia of 6—8 D, but rarely in very young individuals. Jäger observed characteristic coni in some new-born children, and Mauthner saw large crescents in children 3 years old. Stellwag, in 220 cases of myopia of 6—20 D, found absence of the crescent in 21; similar statistics by Seggel give a smaller proportion, and he attributes the myopia in these cases to increased corneal curvature. Mauthner differs from these observers in saying that the crescent is absent much more frequently, even in high myopia, and Schmidt-Rimpler, from investigation of school children, concludes that whilst the frequency and size of coni increase with the degree of myopia, they are absent in 20

per cent. of cases with as much as —6 D. Schleich, in 1,026 cases, found no crescent in 18 per cent., it was narrow in 42 per cent., broad in 22.4 per cent., and annular in 9.5 per cent. Whilst Schmidt-Rimpler's statement is true in the main, there is no inevitable relationship between the degree of myopia and the size of the crescent; cases of high myopia with only a narrow crescent are not very uncommon. Schnabel, in 135 cases with coni, found 99 myopic, 18 emmetropic, and 18 hypermetropic. Hertel gives the following statistics:

Position.	Number of cases.	Per cent. of all conus cases.	Per cent. of all myopes.
Temporal	4598	79	69
Annular	642	11	9.6
Inferior	349	6	5
Superior and supero-internal	233	4	3.5

Per cent.
In myopia of 1— 5D the crescent was absent in 15.5 of all myopes.
In myopia of 6— 8D the crescent was absent in 9.8 of all myopes.
In myopia of 9—16D the crescent was absent in 3.5 of all myopes.

Corresponding statistics from E. Bock are:

Per cent.
In myopia of 6— 9D the crescent was absent in 36.96 of all myopes.
In myopia of 9—12D the crescent was absent in 17.2 of all myopes.
In myopia of 12—20D the crescent was absent in 11.5 of all myopes.

Supertraction of the retina was first described by Jäger in 1861: he noticed in a highly myopic eye a faintly pigmented crescent on the nasal side.

Behse (*Ophthalmic Year-Book*, p. 86, 1909) has examined 11 myopic eyes, of which 5 showed the fundus changes characteristic of high myopia. He finds that the conus generally depends upon localized atrophy of the choroid and pigment epithelium due to excessive distension. Stilling's traction crescent, Heine's incarceration of a layer of the nerve head between the choroid and the retina occur, but they are rare. The atrophic foci are also the result of distension, and are divisible into choroidal and retinal. Where in the former the lamina elastica is ruptured, a white spot appears bordered by pigment, though the latter is sometimes absent. In the spot itself, tough connective tissue is present, or else the choroid is so thinned as to show the sclera. The marginal pigment is derived from proliferated

epithelium. Where the rupture of the elastic membrane is minute, the solution of continuity may be entirely filled up with pigment epithelium, giving the appearance of a small round black spot. If the elastica is not ruptured, small, pretty sharply defined white foci of choroidal atrophy occur, with absence of pigment as a rule. It is evident anatomically that brownish-black foci may be due to immigration of pigment into the retina, but such can not be distinguished with the ophthalmoscope from foci of other origin.

Conus, Congenital. Fuchs' coloboma. See **Conus.**

Conus, Opticohyaloid. This remarkable, most unusual—if not unique—congenital malformation is pictured and described in Oeller's *Atlas of Rare Ophthalmoscopical Conditions.* In the words of the translator: "On ophthalmoscopic examination the structure which projects far forwards into the vitreous falls into two parts: the posterior and larger *lies like a disc or flat button in front of the probable point of entrance of the optic nerve;* the anterior projects into the vitreous as a uniformly broad cone. This button which completely covers the optic disc is pressed quite flat and has a diameter almost twice that of the papilla. The margin which is nearly circular is gently bevelled off, but it must really be an overhanging one as the narrow shadow, that surrounds it, shows. The disc from its convex anterior surface changes color rapidly according to the position of the mirror. The part that is directly illuminated has a brilliant yellowish-white color, while the neighboring marginal parts that are in shadow appear of a very distinct green. It is evidently perfectly solid, and its exterior impervious to light. Towards the temporal and inferior borders one can see widely-radiating streaks most distinctly, while the nasal margin presents markings with a basketwork-like arrangement. From the outer and lower inner border very short and narrow, isolated, white, sharply defined threads run off horizontally to lose themselves quite imperceptibly in the transparent vitreous. The upper margin of the disc is in the picture concealed by the anterior end of an elliptical cone which has been as it were abruptly broken off; this cone is half as broad as the disc, and appears to be firmly fixed into an opening in the center of the latter from which it stands out clear and projects 4 to 5 mm. into the vitreous. The edges of this cone are parallel; the sides and the anterior, somewhat irregular, broken surface appear perfectly homogeneous, have a jellylike transparency and grayish-green color, and are devoid of any markings; only isolated, short, grayish-green threads project some distance further forward in the vitreous and disappear entirely. Neither the disc nor the cone

shows any movement. The most distinctive feature of this ophthalmoscopic picture are the cords and swellings that emerge from under the flat button and serve to carry the retinal vessels. When directly illuminated, these cords or bands appear light grayish-white. Of the three that run inwards only the middle one lies in the same plane with the retina. The broad central end of the other three bands,

Opticohyaloid Cone (and Disc). (After Oeller.)

however, lies in front of the retina leaving a space so that a fine sound could be passed through between this arch and the retina. One is convinced of this not only by the necessity of changing the focus but by the deep-red color of the shadow at its border. After a short course of about one papilla-diameter the arches, somewhat diminished in size, then enter the plane of the retina into which they pass quite imperceptibly. The band that runs upwards and inwards is much larger than the others, measuring as it does 1½ times the diameter of the disc. The margins of its peripheral end are lined

with black pigment. Its central end shows at the upper and inner border of the disc a gaping slit, through which the red of the fundus appears. In the immediate neighborhood of the upper angle of the slit the band is pierced by a very small artery which has immediately before this given off a straight running branch; the artery itself, however, cannot be traced further. The largest vessel in the whole fundus, too, probably the vena nasalis superior, courses for the greater part along this cord. Three small swellings of the same color as the arches, the one situated above and outside, the other two below and close to each other, project from under the margin of the disc as if overhanging the retina. These arches and swellings now are the support of what are undoubtedly the retinal vessels very much reduced in size. The vessels that run downwards can be followed only a very short distance partly because they are so attenuated, partly because they are interrupted by the overhanging border of the swellings. A small zone of the fundus in the immediate neighborhood of the probable inner edge of the optic disc between the three arches appears light grayish-red in color, as if the result of thickening of the retinal tissue. Small, mostly round, bright yellow or white spots with a gray or black margin shine through the opaque tissue. Above and inwards a large white patch of atrophied choroid with black pigment here and there round the border runs from the upper to the middle retinal band. In close proximity to it and also further down there are several small spots of grayish-black or black pigment scattered irregularly about, and mostly surrounded by a light yellowish-red ring; a larger patch of the same kind stands alone downwards and inwards from the prepapillary disc. The small group of round, white, glistening spots, scarcely as big as a pin's head, that are situated just above the upper and inner border of the disc, at the peripheral end of the lowest nasal retinal band, and also below the two lower swellings, are very probably calcified glands. Close to the centre of the macular border of the disc and in the immediate neighborhood of the lower edge of the inferior temporal arch one sees with a certain position of the mirror a very delicate gray membrane with indefinable margins in the vitreous; and in each a small, sharply defined, round, white spot is imbedded. In the region of the fovea there are isolated, rounded, yellowish-white spots with a gray or black margin, alternating with a large number of tiny yellowish-white dots mostly collected into groups. This gives the fundus in this region a stippled appearance, but not a single vessel is present. Only one short, thin, white thread which forms an arch in its course from above downwards towards

the macula reminds one of an obliterated macular vessel. In the words of the translator: "This case belongs to a period when the system of retinal vessels was just being developed (about the 3rd or 4th month), but it seems also to afford the ophthalmoscopic proof that the retinal vessels actually grow out of the vitreous into the retina. The swellings and bands above described are from their entire appearance undoubtedly of a connective-tissue character. I, therefore, think we are justified in assuming that it is the delicate fibres of the *membrana vasculosa* carrying the embryonic vessels that were converted into firm cords of connective tissue as a result of the chorio-retinitis. But again I would emphasize the fact that the most of these cords which carry the vessels lie in front of the retina. This remarkable fact, I think, is due chiefly to two causes. In the first place the process of drawing the hyaloid artery into the optic nerve in order to take up its final function as the *arteria centralis retinæ* may have possibly been interrupted through the extraordinary proliferation of connective tissue in front of the papilla, so that the branches of the vessels that were intended for the retina came to lie in front of the plane of the future retina. A second cause is possibly found in the retinal atrophy, which was due to the chorio-retinitis round the papilla." See, also, **Congenital anomalies of the eye.**

Conus, Sichel. (G.) Myopic crescent.

Conus, Steinheil's glass. Donders (*Accommodation and Refraction of the Eye*, p. 422) gives the following description of this high-power monocular lens for the use of myopes in the distance. It is a simple, solid conus of glass, about one inch long, the base convex, the opposite surface, concave, with a smaller radius than the convex. It acts as a Galilean telescope; parallel rays, refracted on the convex surface, are converging in the glass and, refracted again on the concave surface, obtain a diverging direction, and can also unite on the retina of a corresponding myopic eye. The magnifying power increases for the glass-coni required in high degrees of myopia.

Conus, Underlying. This term has been applied by de Schweinitz (*Text-Book*, p. 126) to the congenital form of the white crescent that lies beneath the more superficial defect in the choroid.

Convallamarin. According to Lewin and Guillery, this poisonous, bitter, yellow, amorphous glucoside, derived from the Lily of the Valley *(Convallaria majalis)*, sets up marked irritation of the eye when instilled in 2 per cent. solution. However, it produces and leaves an anesthesia of the anterior eye that persists for an hour. Meyer (*Archiv f. exp. Pathol.*, 1893, p. 115) found that 1 per cent.

solution causes first contraction and then dilation of the pupil in hens and pigeons, the mydriasis lasting for several weeks.

Convention of signs. In *optics,* an agreement among physicists to adopt a definite direction as being positive (+), the opposite direction being negative (—), for distances that are measured from a fixed point. *Continental convention,* among physicists of continental Europe, the stipulation that all distances measured from a given point, such as the pole of a mirror or the center of a thin lens, are to be counted positive when they agree in direction with the propagation of the incident light, and negative, in the opposite direction. Therefore, convex lenses have positive (+) focal lengths, and concave lenses, negative (—) focal lengths. *English convention,* though not universally used among all English or American authors, stipulates that distances are to be taken positive when they are measured in a direction opposite to that of the incident light, and negative in the reverse direction. This provision results in concave lenses having positive focal lengths and convex lenses negative focal lengths, which is contrary to the prevalent conception among both ophthalmologists and manufacturing opticians throughout the world, and who, therefore, adhere both in theory and practice to the *continental* convention.—(C. F. P.)

Convergence. Convergence is the power of directing the visual axes to a near point. It is brought about chiefly by the contraction of the internal recti. There is generally a close relationship between convergence and accommodation, although accommodation may be paralyzed and convergence be unaffected. Far and near points (mentioned in connection with accommodation) are terms also used in describing convergence.

The *far point of convergence* is the point at which the visual lines are directed when convergence is at a minimum, as when the eyes are directed toward an object 6 metres or farther way. The *near point of convergence* is the point at which the eyes are directed when turned inward to the greatest degree. It is evident that when the eyes are directed to a distant object the visual axes are parallel. If the lines diverge, they can meet only when projected backward; hence the term *negative convergence.* This is determined by finding the strongest abducting prism (apex of prism being toward the temple) with which the patient can overcome double vision when looking at a flame 6 metres distant. In the practical application of the test the patient keeps both eyes open, the prism being placed before one eye only. This gives in degrees the amount of negative convergence.

In this connection, also, the term *metre-angle* has been used. When

the eyes converge to a point directly in front of them, and 1 metre distant, the amount of convergence toward the middle line is called 1 metre-angle. If they are directed to points ½, ¼ or ⅛ of a metre distant, the convergence is, respectively, 2, 4, and 8 metre-angles. Likewise, when directed to a point 2 metres distant, the convergence is recorded as ½ metre-angle. Accommodation for the near point is called positive convergence, and is found by having the patient hold a hair-optometer at a distance of 25 centimetres from his nose. Both eyes are to look at a bead placed on one string of the optometer; and the instrument is advanced toward the patient until the bead appears double. When this point is ascertained the distance is read off by means of the dioptre steel tape and the number of metre-angles of convergence is recorded. The average normal eye shows as many metre-angles of convergence as of dioptres of accommodation. Thus, when the eyes are directed at a point distant ¼ metre, the eye requires 4 D. of accommodation and 4 metre-angles of convergence. The relationship thus existing in normal eyes is much changed in ametropia. The hypermetropic eye calls on its accommodation before convergence is necessary. In the myopic eye the reverse is the case.

The power to maintain convergence is determined by the use of the gold bead on the optometer, and a shield. The patient holds the optometer at the distance required in his work and looks at the gold bead with both eyes. The surgeon now covers one eye with the shield, which is immediately removed and the effect noted. If there is no movement of either eye convergence is maintained properly (orthophoria). If one or both eyes move when covered, and then move back to the primary position when uncovered, there is heterophoria. Its amount can be found by the following method: A word cut from Snellen's smallest test-type is pasted on a piece of white card. A vertical line is drawn through the centre of the word. A trial-frame is used; a prism of 6°, base up, is placed before the right eye. The word and line are looked at with both eyes and are seen doubled. The lower image belongs to the right eye, and should be seen immediately under the upper. If it does not occupy this position, but is placed to the right or left of the upper image, the deviation is to be corrected by placing a prism horizontally of sufficient strength to cause the images to appear in proper position.

In making a test of convergence it is necessary that a patient who wears glasses for near work shall have the lenses properly centered. If decentred, they will act as prisms and will cause deviation.—(J. M. B.)

A simple device for testing the convergence power is the invention of Mark Stevenson and is fashioned after the stereoscope. The lenses consist of prisms which cause vertical diplopia. A card, held at the end of a frame, ¼ metre from the prism (see the figure), is composed of small letters arranged in a horizontal line on each side of a vertically placed arrow. The letters on the right of the arrow run from A to R, and those on the left from Z to J. Since all efforts at fusion are abolished, the normal convergence induced by accommodation is in evidence. If the balance is normal the two arrows are seen one above the other. If there is convergence insufficiency, the lower arrow will be seen to the right, pointing to one of the letters above. If con-

Stevenson's Convergence Power Test Apparatus.

vergence excess exists, the lower arrow will be seen to the left, pointing to a letter above. The letters are so arranged that each one removed from the right or left of the center arrow represents one degree of convergence excess or insufficiency.

The instrument must, of course, be made so that the prisms are correctly placed, and not rotated toward or away from each other. See, also, **Accommodation,** and **Physiological optics.**

Convergence, Dynamic. This is the active, inward rotation of the eyes when a near object is fixed immediately after looking in the distance.

Convergence, Excessive. In *excessive convergence* there is orthophoria or slight esophoria for distance and marked esophoria for near. The near point of convergence is very close to the eyes. The adducting power is high and the abducting power may be low. Disturbance of vertical equilibrium affects the lateral equilibrium and may aggravate or even originate lateral deviations.—(J. M. B.)

Convergence, Insufficiency of. See **Adductive Power, Weakness of,** as well as **Exophoria.**

Convergence, Macular reflex of. This is an expression suggested by Parinaud (*Annales d'Oculistique,* 1896, p. 401) for "binocular vision." He considered this reflex as comparable to the accommodative reflex of convergence.

Convergence, Power of. The power of convergence can be measured in metre angles (see **Convergence**) or by determining the near point of convergence, and also by the power of the internal recti muscles to overcome the diplopia produced at twenty feet (six metres) by prisms placed with the bases toward the temple before the eyes. In order to estimate the near point of convergence it is only necessary to approach a pointed lead-pencil to the eyes along the median line and measure the distance from the eyes at which the point begins to appear double. This should be at about six centimetres (two and one-half inches). Prism convergence varies greatly within normal limits, ranging from 25 to 70 degrees or even more.—(J. M. B.).

Convergence ratio. In *optics,* the same as *angular magnification.* See page 477, Vol. I, of this *Encyclopedia.*

Convergence reflex of pupil. Argyll Robertson sign. See Vol. I, page 567, of this *Encyclopedia.*

Convergence, Spasm of. This is rather a rare symptom, but many authors, among them Parinaud and Gowers, believe that convergent strabismus and other symptoms may be produced by it.

Convergence, Static. Worth (*Squint,* p. 3) denies the existence of such a thing as static convergence because, he says, the primary position of the visual axes is one of parallelism. In a case of convergent squint, however, there is a static convergence corresponding to the angle of the deviation.

Convergence, Weak. See **Exophoria.**

Convergent. Tending towards a common point.

Convergent lens. A convex lens that causes refracted rays of light to converge to a real focus.

Convergent rays. Convergent rays of light do not exist in nature; the latter are invariably divergent. It may be said that only such rays converge as have passed through a convex lens, or have been reflected from a concave mirror.

Convergent squint. Esotropia. Convergent strabismus. Internal squint. Crossed eyes. Comitant convergent squint. There are three varieties recognized: *permanent monocular, permanent alternating,* and *periodic.* Permanent monocular squint is the most common. It usually makes its appearance at the age at which the child first begins to be interested in near objects, such as toys, picture-books, etc.—about two years of age. It may, at first, be periodic,

but soon becomes permanent and monocular. Its origin is almost invariably attributed by the laity to whooping-cough, fright, imitation, or to the attraction of the child's sight to some object hanging overhead. The most frequent, but not the only, cause is hypermetropic refraction. This operates to produce it through the excessive convergence of the visual axes, which accompanies the extra amount of accommodation required in hypermetropia to see distinctly at a given distance. Normally, for each angle of convergence an equal degree of accommodation is employed. In the hypermetrope this balance is disturbed from the beginning, since, in order to see distinctly at a distance, the hypermetrope must accommodate to the degree of his hypermetropia and still maintain parallelism of the visual axes. Now, when it comes to viewing an object at near range, say thirty-three centimetres, the hypermetrope will require as many dioptres of accommodation in excess of the three dioptres normally associated with three metre angles of convergence as he has dioptres of hypermetropia, and as a result of this one of two conditions must prevail: either he must be satisfied with blurred, but single, vision (both eyes converged to the object, but accommodation insufficient), or he may secure distinct vision (both eyes accommodated for the object, but convergence excessive), which will produce double vision unless he permits one eye to turn in, and this is the solution of the difficulty which the patient instinctively accepts. Ninety-eight per cent. of the cases of convergent squint are hypermetropic. Other causes of convergent squint are:—

1. Congenital weakness of the external rectus muscles.
2. Esophoria. This would be particularly apt to produce convergent squint if from any cause one eye is amblyopic, or the retinal image is distorted or faint as the result of opacities in the cornea or other of the refractive media.
3. Divergence insufficiency.
4. A high positive quality of the angle gamma would tend to the production of a convergent squint.
5. Failure of development of the fusion centre (Worth).

In convergent squint the result of hypermetropia, the deviating eye, in more than half the cases, is found to be amblyopic. The causal relationship between the squint and the amblyopia still remains in dispute, some authorities looking upon the amblyopia as the result of the squint from disuse of the eye, and others regarding it as the cause of the squint by removing the stimulus to convergence which would be excited if there was a tendency to diplopia. The absence of diplopia in comitant strabismus may be due to the suppression of

the retinal image, or it may arise from the development of new identical points in the retina of the deviating eye.

The *angle of squint* is the angle which the visual axis of the deviating eye forms with the direction which it should have in a normal condition (Landolt).

Determination of the angle of squint.—Much ingenuity has been displayed in devising methods for the ready estimation of the angle of squint, and of these methods three will be detailed—those by the perimeter, by prisms, and by the linear method, or strabismometry.

In determining the strabismic angle *by the perimeter,* the patient is seated before the instrument with both eyes uncovered, and is directed to look at the object on the arc-arm, or at a candle-flame held on the visual line at a greater distance. While so doing a second lighted candle is carried along the arc of the perimeter, and the examiner, with his eye placed directly behind this candle-flame, notes when the image of the flame falls upon the centre of the cornea of the deviating eye, and when this has come to pass the angle of the squint may be read off in degrees. The centre of the cornea is employed because it is impossible to determine the visual axis by this method; consequently the result obtained is only approximately correct, as it does not take into consideration the difference which almost invariably exists between the optic axis and the visual axis and the resulting angle formed by the crossing of these two lines at the principal optical centre. In order to be exact, this angle must also be estimated and its value added in convergent squint and deducted in divergent squint from the angular determination. A modification of the perimeter test is the Priestley Smith tape-measure test, in which no allowance is necessary for this angle.

The method *by prisms* is applicable only where diplopia exists spontaneously or can be induced. When diplopia does not exist spontaneously, which is the rule, it may sometimes be induced by placing a red glass before the eye with the better vision; this failing, a prism should be placed vertically before one eye, and, by thus throwing the image on to a different part of the retina, diplopia may often be excited. Prisms are to be held horizontally before either eye of sufficient strength to fuse the two images if diplopia be induced by the first method, or until the images stand one above the other, if diplopia be induced by the second method.

A second method of employing prisms to measure the degree of deviation is in connection with the cover test. That prism is a measure of the squint which maintains the visual axes directed to

the fixing object held about forty centimetres before the eye when the cover is transferred from one eye to the other.

To apply the linear method, a ruler is held close against the lower lid of the squinting eye, and the divisions corresponding to the centre of the cornea when the eye is made to fix a distant object, and when it again is allowed to assume its abnormal position, are noted. The difference is a measure of the squint. A special instrument called a strabismometer may be used. This test is not without value in determining the length of the piece of muscle desirable to remove in performing advancement with resection of the muscle in high degrees of squint, but, as is insisted upon by Landolt, it is manifestly incorrect to speak in linear terms of an angular quantity.—(J. M. B.)

According to Worth (*Squint*, p. 25), "Two essential conditions are present in every case of comitant convergent squint: (1) An abnormal convergence of the visual axes. (2) A defect of the fusion faculty. Other conditions may also be found. (3) The vision of the eye which is not being used for fixation is almost invariably suppressed. (4) There is, in rather rare instances, more or less congenital amblyopia. (5) There is very often acquired amblyopia in the deviating eye, as the result of neglect or inefficient treatment. (6) There is usually a refractive error, commonly hypermetropia and hypermetropic astigmatism. In a healthy person, with a normal fusion faculty, the "desire for binocular vision" causes the two eyes to be directed steadily to the same object. But when the "desire for binocular vision" is absent there is no special reason for this perfect accord between the movements of the two eyes, so that any slight cause may then upset the equilibrium of the convergence centre, and so cause the visual axes to assume permanently faulty relative directions. Then, when the patient is looking at a distant object, instead of the visual axes being parallel they are convergent. But, in order to see the object distinctly, the patient must look directly at it with one or other eye. He will naturally choose the eye which has the smaller refractive error. He cannot overcome the abnormal convergence, neither can he move one eye without the other. He therefore makes a conjugate lateral movement of both eyes until he has brought the better eye into the required position, the other eye turning still more in towards the nose. So that the better eye becomes "straight," and the worse eye manifests the convergence of both. The eye which is used for vision is called the fixing eye; the other eye is called the squinting or deviating eye. If the patient fixes, say, with the right eye and turns in the left, he is said to have convergent squint of the left eye. This is a useful convention, but it must be remembered

that it does not accurately describe the condition, as, of course, convergent squint really concerns both eyes and certain cerebral functions as well. In a case of convergent squint the separate movements of each eye are perfect. When one eye is covered, the other eye can move upwards (superversion), downwards (subversion), inwards (adversion), and nearly always outwards (abversion) to the normal extent. In 1,523 cases of convergent squint, in which I noted the power of abversion of each eye separately, I found it perfect in 81 per cent. The remaining 19 per cent., in which abversion was deficient, were almost all cases of long standing. The defect of abversion was less uncommon the longer the duration of the deviation. The conjugate movements of the two eyes are perfect. When the fixing eye moves in any direction, the deviating eye moves through exactly the same angle. When the (previously) fixing eye is screened, and the patient fixes with the (previously) squinting eye, the screened eye manifests a deviation exactly equal to that formerly exhibited by the other eye. In other words the squint is comitant. In a case of uncorrected anisometropia the patient may accommodate to a different degree, according to the eye he uses. This may make the squint appear to be not strictly comitant."

Since the great majority of cases of convergent strabismus are associated with or have their origin in an error of refraction, the first step in their *treatment* consists in correcting the error. The total error of refraction should be determined under complete paralysis of the ciliary muscle, secured preferably by the use of atropin, and the glass which is found to correct it should be worn constantly. By the aid of ophthalmoscopy and retinoscopy the refraction status can be quite accurately determined, even in very young children, and at the age of three years they may be given glasses to wear. Experience has demonstrated that, by this method of treatment, the visual axes are rendered parallel in cases of moderate degree. The parallelism is maintained so long as the glasses are worn, the eye reverting to its faulty position as soon as they are removed. In cases where convergent squint manifests itself before the age at which it would be deemed advisable to place spectacles on the child, a course of atropinization for the purpose of relaxing the convergence by paralyzing the accommodation should be employed. A weak solution of atropin (gr. j to ℥j) should be instilled into the fixing eye twice daily for periods of two or three weeks, until parallelism of the visual axes may be brought about by correction of the refraction error, care being taken not to get the toxic effect of the drug and to shade the eyes from bright light. In a few cases the primary effect of the atropin will be found to in-

crease the squint as the result of the excessive accommodation innervation which is induced by the attempts of the patient to see distinctly (Savage).

Orthoptic treatment.—For success with this method diplopia must exist; and, if not present spontaneously, it must be induced. This condition obtaining, a stereoscope, in which the prisms have been replaced by convex spheric lenses of 6 D. strength, and in which the distance between the stereoscopic pictures for the two eyes may be increased or lessened at pleasure, is employed to stimulate binocular vision. The test pictures must be placed at the focus of the lenses so that they will be plainly seen without accommodation, and, associated convergence being stimulated,—if the visual axes be parallel, and the pictures be not too far apart,—the two images will be fused into one having the third dimension. Where the visual axes converge, the pictures must be approximated until both eyes see simultaneously. After this has been accomplished actual fusion and restoration of binocular vision may be expected. Where there is unequal acuity of vision in the two eyes, difficulty will be experienced in inducing the eye with the reduced visual acuity to perceive the picture corresponding to that eye. Equalizing the visual acuity of the two eyes by fogging the sight of the better-seeing eye, by using a higher plus lens than is before the other eye, or repeatedly and momentarily excluding the better eye, will be found of assistance. The amblyoscope of Worth also will prove useful in developing the vision of amblyopic eyes and in bringing about binocular vision if employed during the years the fusion faculty is developing—that is, before the child is six years of age. The patience and time required to secure results, and the limited field of usefulness of this form of treatment, have interfered with its securing the position it deserves. It will also be found of service in restoring binocular vision where operation has produced spontaneous diplopia. Should the above methods fail to restore parallelism to the visual axes, the question of operative intervention must be considered. No unanimity exists among surgeons, either as to the method to be pursued or as to the age at which it should be undertaken. Without entering into a discussion of the reasons it may be stated that the operation of advancement of the tendon of the muscle more nearly restores the normal physiologic and anatomic relations than does tenotomy. However, owing to the ease with which it may be performed, tenotomy is the prevailing method of procedure, but it is rarely performed by the writer. No operation should be performed until the patient has arrived at an age at which a comprehensive study of the conditions can be made and the

co-operation of the patient can be obtained in restoring binocular vision. Nor should it be delayed until time has effaced the faculty of binocular vision. As to the results to be expected from the performance of tenotomy, it may be stated for general guidance that a tenotomy of a single internal rectus muscle, without a too free dissection of the reflected fibres of the capsule of Tenon, will correct about 15 to 20 degrees of deviation; and a double tenotomy, from 20 to 35 degrees. The effect will be somewhat less after the same operation on the external muscles. For higher defects a tenotomy with advancement of one or both of the opposing muscles may be required.—(J. M. B.)

Our attention is drawn by Jackson to the fact that advancement, like tenotomy, has its failures. No operative treatment of convergent squint can be regarded as rational which does not attempt to correct abnormal contraction of the nasal fibers of the superior and inferior rectus which come into play when the eye is strongly adducted. These muscles are accordingly to be considered as secondary abductors and adductors. Simple tenotomy increases their action by diminishing the power of the primary abductors and adductors, which tend to bring the eyeball into the primary position. In high degrees of convergent squint Jackson performs a partial tenotomy, dividing the inner nasal fibers of the upper and lower rectus. In very high degrees the extended tenotomy may be combined with advancement. A case is reported which shows the permanence of the results obtained by extended tenotomy.

The *operative treatment,* as well as much additional matter relating to this subject will be found under **Muscles, Ocular,** to which the reader is further directed.

Convergent strabismus. A synonym of *convergent squint* (q. v.).

Convergenzbreite. (G.) Magnitude or range of convergence.

Convergenzgefühl. (G.) Convergent sense.

Convergenzkrämpfe. (G.) Spasm of convergence.

Convergenzlähmung. (G.) Paralysis of convergence.

Convergenzlähmung durch Blei. (G.) Paresis of convergence due to lead poisoning.

Convergenznahepunkt. (G.) The near point of convergence.

Convergenzschwäche. (G.) Weakness of or defect in convergence.

Convergenzwinkel. (G.) Angle of convergence.

Converging lens. A lens, either double-convex, plano-convex, or concavo-convex, which causes all the rays of a pencil of light to converge at a point.

Convergiscope, The. This is the trade name of a binocular magnifier or condensing lens. It is designed to secure the direction of the visual axes to the exact point of examination. The object is brought out in sharp relief and the solidity of stereoscopic effect is produced. The instrument consists of a pair of specially shaped lenses carefully centred and fitted in an aluminum mount, the angle being arranged by Berger of Paris. The optical part is fitted into a hood made of very fine black straw. The whole weighs less than 2¼ ounces.

The Convergiscope.

Convex. In optics, a lens or a mirror with a spherical surface.

Convex cylindric lens. A lens having one convex cylindric surface and the other plane. Also called a *plano-convex cylindric lens.*

Convex lens. A glass having one or both surfaces convex, proportioned so as to produce a lens that is thickest in the center. See **Lens.**

Convex mirror. In optics, a convex surface of polished glass or other suitable substance that forms virtual images by the reflection of rays of light. See **Mirror.**

Convexo-concave. In *optics*, applied to a lens, convex on one side and concave on the other, meaning that its *convex* side is exposed to the incident light. The lens may be either one of two forms: convex, thickest in the center, a *meniscus;* or concave, thinnest in the center, a *contra-meniscus.* See **Ophthalmic lenses and prisms.**

Convexo-concave lens. CONCAVO-CONVEX LENS. See the major heading **Lens.**

Convexo-plane. In *optics,* applied to a plano-convex lens to indicate that its convex side is exposed to the incident light. See **Ophthalmic lenses and prisms.**

Convexspiegel. (G.) Convex mirror.

Convolvulus palmatus. (L.) A species found in the West Indies, the flowers of which are used in various forms of "ophthalmia."

Convolvulus peltatus. (L.) A species found in the Moluccas and Society Islands; used as an application to corneal opacities.

Convulsé. (F.) Said especially of a muscle subject of convulsive contractions.

Convulsibility. Tendency of a muscle to convulsive twitchings.

Convulsive tic. A term, sometimes used of the ocular (as well as of other) muscles to denote involuntary jerking, or twitching movements.

Coondumunnie. (Tamil language.) The Abrus precatorius.

Cooper-Swanzy sign. A synonym of the so-called Dalrymple's sign (retraction of the upper eye-lid) seen in *exophthalmic goitre* (q. v.).

Co-ordination of eye-movements. The various ocular excursions and their relations will be described and discussed elsewhere. (See references below.)

Among other observers Coutela (*Arch. d'Ophtal.,* July, 1909) summarizes the movements of the eyes, normal and pathological, as follows: Normally the eyes perform only associated movements of direction and convergence; these movements are governed by an extremely complex nervous mechanism comprising, in addition to peripheral bulbo-protuberatial centers (nuclear centers), co-ordinating centers. The latter are extra- and supra-nuclear, some being situated in the mesocephalon near the tubercula quadrigemini (inferior or mesocephalic oculo-co-ordinating centers), while others are cortical or superior. Non-paralytic disturbances are (1) the synergic, those occurring in repose (nystagmus); (2) also synergic but called forth as movements are initiated; (3) motor inco-ordination —true ataxia—the movements of the two eyes being entirely dissociated. Kohnstamm's and Quensel's researches tend to complete the theory of the anatomical basis of the nervous mechanism of ocular movements. See, also, **Convergence**; **Orthophoria**; as well as **Muscles, Ocular.**

Copiopia. Neurasthenic asthenopia. Copiopia symptomatica (Königshofer). Weariness of the eyes. Weak eyes. Copiopia hysterica (Förster). One of the best descriptions of this exceedingly troublesome affection is given by Königshofer (*Encyklopädie der Augenheilkunde,* p. 54) who says that it is signalized by a series of

symptoms referable to the trigeminus, and by fatigue phenomena of ocular muscles. Patients complain of dull pressure or piercing pain about the eye, in the orbit, behind the eyeball, in the forehead, about the nose or even in the upper jaw. The pain may radiate over the entire head and extend to the cervical region. They also report burning and dryness of the eyes, heaviness of the lids, foreign body feeling and occasionally chilly sensations and extreme fatigue of the eyes upon the least use of them for either distance or near. Sensitiveness to light is invariably well-marked, especially with artificial or reflected light. Although the pain never appears without some external cause, yet the slightest attempt at accommodation or when exposed to strong illumination, or, occasionally, even bodily exertion or mental excitement, may induce the pain.

The above symptoms do not appear in full force in every case; all possible gradations are observed. We find cases in which complaint is made of only one of the foregoing symptoms. Sometimes the only complaint is fatigue following use of the eyes, especially, when the illumination is weaker or stronger than usual.

The clinical picture, therefore, displays the same symptoms that one finds in disturbed accommodation, a high degree of hypermetropia, insufficiency of convergence, conjunctival catarrh, ciliary and trigeminal neuralgia, or migraine. It is also noticed that the complaints vary greatly, and the patient has good and bad days. We further find the statement that the eyes feel better in the afternoon than before dinner, or, vice versa.

The characteristic point about a true copiopia is that an examination of the eyes reveals no adequate ocular explanation for the condition. Accommodation, clearness of vision, and muscular activity are often normal, though the conjunctiva may perhaps show a slight hyperemia. If we find anomalies of refraction or accommodation, or diseased lids or conjunctiva, these conditions are in no way proportional to the complaints made by the patient. Correction of a refractive anomaly, for instance, or the removal of objective symptoms of disease exert only a very slight influence on the symptoms. Accordingly the diagnosis must be made by exclusion.

The disease affects people of both sexes between the ages of eight and fifty; in men mostly between the fourteenth and thirtieth year.

The affection is purely symptomatic and follows some cause that weakens or deranges the nervous system. It is frequently observed in females and accompanies changes in the position of, or is due to inflammatory processes in, the uterus. It also accompanies functional disturbances or perversion of sexual activity in either sex. It is also

seen in hypochondriacs, neurasthenics, those suffering from the so-called traumatic neuroses; in chlorosis and anemia; it also occurs as a symptom of systemic weakness following fevers and other general infectious diseases. On the other hand it is not a common sign in pure hysteria although it may accompany hysterical stigmata.

In sexual cases, hypochondriacs and neurasthenics, as well as in cases of systemic disease the prognosis is usually good; it is fairly good in cases of traumatic neurosis, and poor when accompanying uterine affections. In the latter case it does not disappear until after menopause.

Treatment should be tonic and directed against the causative or accompanying malady. For the pain Förster recommends castor. canad. 2,0, extract valeriani 4,0, to be taken internally during four days. For the photophobia one should prescribe fairly dark, neutral or other form of tinted glasses. The various forms of electricity, both local and general have been found useful.

Shahan (St. Louis) reporting two illustrative cases of the disease (*Ophthalmic Record,* Dec., 1911) thinks that Förster intended by the term *copiopia hysterica* to indicate a condition in which most of the symptoms of accommodative asthenopia of hypermetropia were present, either in the total absence of such asthenopia, or in the presence of its complete correction. The symptoms consist of headache, pain about the eyes and in the globes, ability to read only a short time without distress, and of photophobia. The eyes are naturally suspected of being at fault. Nevertheless the pathogenesis of the disease appears to have no ocular basis whatever but to be dependent upon long standing disease of the uterus and its adnexa, with reflex irritation of the fifth and optic nerves. Those of us who have had such cases to deal with know how troublesome they are.

The photophobia, Shahan points out, is most marked in artificial light whatever it may be, electric, gas, or petroleum, and he thinks that this indicates a hypersensitiveness to long light waves which are preponderant in all such illuminants.

As to treatment he has found pilocarpine drops of real value and holocaine also during the height of an attack.

The patient should have systematic treatment at the hands of a gynecologist.

Königshofer suggests the term *copiopia symptomatica* because he thinks it is never dependent upon a pure hysteria but is evidence of a series of irritations of the fifth and optic nerves due to diseases or anomalies of the sexual organs, to neurasthenia, chlorosis, or infectious diseases.

It is important to recognize that the condition is not an ocular disease.

The following are Shahan's two cases: Case 1.—Female, age 34 years, gave a history of pain in her side since the birth of her third child seven years previously. She also had an operation for the removal of the appendix and the left ovary fourteen months previously. She complained of photophobia, headache and ability to read only a few lines at a time without discomfort; and stated that she had always been near-sighted. She had a moderate myopia associated with a high myopic astigmatism. No improvement could be made in her correction. The conjunctivæ were normal, the pupils rather large and the fundus of each eye normal, except for a slight stretching of the choroid about the disk. The fields were somewhat contracted.

While the first attack subsided under the instillation of biborate of sodium, the subsequent attacks, which were worse at the time of menstruation, failed to respond to various medicinal, refractive and psychic expedients. Rigid control and supervision of the gynecological conditions were not possible in this case, and when last heard from her condition was not satisfactory.

Case 2.—Female, age 21 years. There was a history of a curettement soon after her marriage and for several years she had pain and tenderness in her left side. She complained of pain in the head, "behind the eyes, and in the eyeballs," inability to read without getting headache and eyeache, and photophobia. Aside from a hyperopia of two diopters her ocular condition was normal. The attacks of severe pain were accompanied by nausea and vomiting. A gynecologist reported an "infiltration of the left parametrium and about the left adnexa, and some endocervicitis." In this case the pupils were also larger than normal and pilocarpin appeared to be of real value as it was in the other case, probably by shutting out some of the excessive light. Holocaine was also of value during the height of an attack. After prolonged nonoperative gynecologic treatment she improved in every way. Shahan stated that the photophobia in these cases was most marked in artificial light, which seemed to indicate a hypersensitiveness to long light waves.

Copirstifte. (G.) Anilin (copying) pencils, that are occasionally, especially by children, thrust into the eyes to their material damage.

Copopsia. (Obs.) Copiopia. Non-ocular weariness of the eyesight or fatigue of the power of acute vision. The term was originally employed to denote a fatigued or worn-out retina, and was often confounded with amblyopia. See **Copiopia.**

Copper. Cuprum. This is the metallic base of many useful salts and compounds used in ocular therapy.

The conduct of those dangerous cases in which fragments of this *non-magnetic* foreign body have entered the eye—as portions of gun-caps, copper wire, etc.—is discussed under **Injuries of the eye**; as well as under **Copper in the eye.**

Copper, in various forms, was an oft-used remedy in the hands of ancient Greco-Roman ophthalmologists. Metallic copper, flowers of copper, copper scales, verdigris, and the various sorts of copper ore were all employed. The chief diseases in which these forms of copper were thought to be of value were: cataract (hypochyma, or suffusio) glaucoma, trachoma, and ulcers and scars of the cornea.—(T. H. S.)

Copper acetate. Cuprum aceticum. Copper verditer. Crystallized verdigris. This salt forms deep, bluish-green, efflorescent crystals, quite soluble in water and alcohol. Copper acetate is an irritant-astringent. As a lotion it has been recommended in the subacute and chronic forms of conjunctivitis, the collyrium ranging in strength from 1:100 to 1000 of distilled water.

Copper, Aluminated. See **Lapis divinus.**

Copper, Ammoniated. See **Cuprum ammoniatum.**

Copper, Ammonio-sulphate of. See **Cuprum ammoniatum.**

Copper citrate $C_2C_6H_4O_7+2H_2O$. A greenish salt, slightly soluble in water. See **Cuprocitrol.**

Copper in the eye. Fragments of copper (wire, chippings, gun-caps, etc.) in the walls and interior of the eyeball, the result of trauma, present a diagnostic and operative problem quite different from that due to the presence of such magnetic foreign bodies as steel or iron. The localization of the latter and their removal are comparatively easy tasks, but copper fragments are, in every sense, generally difficult to deal with. Although the questions arising from the presence of non-magnetic foreign bodies in the ocular tissues will be considered under **Injuries of the eye**, yet it may be added here that we mostly have to depend upon transillumination, the ophthalmoscope and skiagrams for diagnosis and localization. The removal of copper bodies from the interior of the eye forms quite an entire section apart.

As an example of the methods of dealing with these foreign bodies the following abstracts are given. Haase (*Klin. Monatsbl. f. Augenheilk.*, Sept., 1912) showed by means of a Sachs' transilluminator and the Roentgen rays, a foreign body of metallic lustre behind the lens, imbedded in exudate. There was a perforating injury of the lower

temporal quadrant of the cornea, with hyphema. After forming a conjunctival flap and fixing the eyeball by two conjunctival sutures, Haase tried with an anatomical forceps (through a meridional section in the upper temporal quadrant of the sclera) to remove the foreign body, but in vain. Then the section was enlarged with scissors and the very small foreign body extracted with forceps. This was greatly facilitated by illumination with Haase's head lamp. The eye recovered with V=5/7.

Van der Hoeve (*Klin. Mon. f. Aug.*, 51, May, 1913, p. 643), opposes the views of E. von Hippel with regard to the "relatively small importance of an exact localization of the foreign body, which often lies near the wound, or may be approximately located by the exudations which form around it." Van der Hoeve believes that several exudations may exist in injured eyes, especially at the place of entrance, which need not contain the foreign body, but may resemble the exudation around it. He has seen in numerous cases the copper fragment some distance from the place of entrance, sometimes diametrically opposite, e. g. in the following case. The whole body and both eyes of a soldier were injured by an explosive. The left eye presented a large perforation of the cornea, prolapse of iris, and several pieces of copper in the anterior chamber. After removal of these, as well as the prolapsed iris, the eye healed with V=5/5. The right eye showed only a very small wound, of the size of the head of a pin, in the median line of the sclera, but on account of irritation it had to be enucleated. The Roentgen photographs in the three principal meridians revealed not less than four foreign bodies, each in a different part of the globe, i. e. far apart and far from the scleral wound.

Also the examination of the visual field is not reliable in localization, as the retina may be detached at a different place from the seat of the foreign body. The Roentgen rays give an excellent means for the localization of foreign copper bodies, as illustrated in a case in which the ophthalmoscope showed none in an almost clear media. A large piece of copper 16x7.5 mm. was extracted from the wound, with preservation of the eyeball and perception of light and good projection. Wessely's shells greatly facilitate the exact localization of the foreign body by the Roentgen ray, as shown in a case of a perforation of the sclera, in the lower nasal ciliary region, with much blood and exudation in the vitreous which prevented an ophthalmoscopic view. If possible (additional) skiagrams ought to be made after the operation because of the possible presence of more foreign bodies in the same eye, as in the above mentioned case.

E. von Hippel (*Klin. Monatsbl. f. Augenheilk.*, July, 1912) has

given a brief review of cases of intraocular (copper) foreign bodies, so far published. In 45 instances out of 60 the operative removal was followed by success. In 1894, Leber reported on 40 cases, out of which 25 were operated upon. Of these the extraction succeeded in 18 cases. Two of the eyes were enucleated later. In 7 the form of the eye was preserved; in 8 with a certain amount of vision (from counting fingers at 1 m. to V=1/6).

Von Hippel reports on 15 cases of injuries by copper or brass with pieces remaining in the vitreous. In a child, who was injured by a gun-cap, the small shining piece of copper was seen at about the centre of the vitreous. The lens was slightly opaque. After performing a small iridectomy von Hippel penetrated the lens with a fine pair of anatomical forceps and at once removed the foreign body. The cataract was extracted later, and V. was 5/7, with glasses.

Three eyes were enucleated on account of infection. In the remaining 9 the operation was done by meridional section and large conjunctival flap. Concentrated illumination of the field of operation with electric light the operator regards as of the greatest importance.

Eight of these 10 extractions were successful; in 7 the eyeball was preserved; 5 had V. 5/35, 1/25, 5/15, 5/20, 5/7; in 2 perception of light and projection were good and a farther improvement was expected. All eyes had normal tension and were absolutely free of irritation.

The operation of removal can be performed successfully, if the seat of the foreign body can be approximately determined. The exudates formed around it serve as a guide to the operator. Generally the pieces are aseptic, so that the inflammation rapidly subsides after extraction. If the site of the foreign body cannot be ascertained and the eye is without irritation, von Hippel advises one to wait, as his experience showed that localization became possible later. All optical obstacles must be speedily removed, e. g. cataract by discission and extraction. Since the eye most likely will be lost if the foreign body is not extracted, a certain boldness in these operations is justified. Von Hippel refrains from an operation if the patient has only one eye left that has tolerated the foreign body for a longer time, with preservation of sight.

In Weiss' case (*Ophthalmology*, Oct., 1908, p. 93) a piece of copper wire 5 mm. long and 3 mm. thick was seen in the anterior chamber; the iris and anterior capsule of the lens had been penetrated, with a resulting localized opacity beneath the anterior and posterior capsule. A slight hypopion disappeared after extraction of the foreign body. The vision later equaled 5/5.

Caspar (*Klin. Monatsbl. f. Augenheilk.,* Aug., 1908) removed a piece of copper from the vitreous, through a scleral section. The foreign body had been tolerated over a year, when severe iridocyclitis occurred, threatening destruction of the eye. The final vision equaled 2/30.

In a case observed by Kümmell (*Zeitschr. f. Augenheilk.,* Jan., 1908) a piece of copper had lodged in the eye for three years and a half, when inflammation developed with suppuration; and the foreign body was removed by iridectomy.

It must also be remembered that the *copper electrode* is used as a curative agent in ophthalmology. For example, Dickson (*Ophthalmic Record,* 19, 1910, p. 155) treated twenty-five cases of long standing trachoma with the copper electrode. A current of 3, 5, 8 ma. was employed for eight minutes until a green deposit from the electrode was left on the conjunctival surface of the lids. Granulations, scar-tissue and pannus yielded to the treatment.

Copper-lecithin. A. Strauss (*Deutsche Med. Wochschr.,* 1912, No. 45, p. 2122) has introduced a new therapeutic process, the so-called Finkler method of treatment with copper-lecithin, into the therapy of *epithelioma;* it was first described by Linden and E. Meissen (*Beiträge z. Klin. d. Tuberkulose,* Vol. 23, No. 2 and *Zentralbl. f. d. gesamte Arzneimittelk,* 1912, Nos. 8 and 9, p. 401). According to Strauss, copper-lecithin is a combination of lecithin and copper chloride, containing 4.5 per cent. of copper. The three cases described by the author, two cases of pure epithelioma and one of primary lupus, were treated with an ointment which was prepared from copper-lecithin and alcohol without the employment of fat. The curative action of this ointment depends in the first place on the action of the copper salt; it cannot yet be said with certainty whether the lecithin component also takes part in the action. But it is quite possible, when it is considered that choline, a product of decomposition of lecithin, as was found by Werner and Schwarz (Compare *Merck's Report,* 1907, p. 74), is capable to a certain extent of substituting X-rays, and that choline itself has received consideration in the treatment of cancer. The results obtained by Strauss in the local employment of copper-lecithin will perhaps lead to the investigation of the chemotherapeutic action of the new drug in carcinoma, in the form of injections, enemata and inunctions.

An ulcerating epithelioma, about the size of a lentil, which was not healed with cauterization by solid carbonic acid, was cured within a week by treatment with copper-lecithin. The second case, an ulcer at the angle of the nose, which had been present for two years and

had been diagnosed as squamous-celled carcinoma, cicatrized in the course of two months. The third case, probably a lupus-carcinoma of the nose, which had been treated in vain for years, also showed a tendency to healing and cicatrization of the ulceration.

In a further communication on his chemo-therapeutic work Strauss speaks of preparations which he describes as combinations of inorganic or complex copper salts with lecithin. He used them with and without the addition of methylene-blue iodide (the hydriodic acid salt of methylene-blue) in lupus and external tuberculosis. For general treatment, the most suitable preparation, according to the author, is a solution prepared from a complex copper salt (with or without lecithin), which is given by intramuscular injection. The ointments also proved useful. The copper-lecithin preparations are administered internally in the form of capsules and pills, and iodine methylene-blue in capsules.

According to the author's instructions, small doses are given at first, especially to sensitive patients; 0.25 to 0.5 c.c. is given and increased to 1 c.c., which contains 0.01 gramme (1/6th grain) of copper; for intravenous injection up to 0.1 gramme (1½ grains) in 10 c.c. of water. At first two injections a week are given, later one injection. Inunction cures should be carried out like mercury cures, 3 to 5 grammes (45 to 75 grains) being used daily. Apart from transient cutaneous irritation, they give rise to no ill effects. For internal treatment, pills, capsules or tablets are given once to three times a day after food, according to the amount of copper they contain. Local treatment is just as simple as general treatment. In large areas of lupus it is best to treat isolated areas, especially in very sensitive patients. Ointments are either energetically rubbed in two to three times a day, or they are applied spread on gauze. To alleviate pain, heroin or morphine is given for a few days. When a reaction has occurred, the following ointment is to be prescribed for healing purposes: Bismuth. subgall. 3.0 grammes (45 grains); liquor alumin. acetic. (20 p.c.) 3.0 to 6.0 grammes (50-100 min.); eucerin. anhydric. ad 30.0 grammes (1 oz.). 10 p.c. of cycloform may be added to this ointment. When the reaction has been checked by this ointment, the cure is to be repeated until all infiltrations have disappeared. This local method of treatment is especially indicated in lupus. In a few cases of erythematous lupus these drugs failed, but the local treatment of epithelial cancer gave good results. (*Merck's Reports,* 1912.)

Copper nucleinate. See **Cuprol.**

Copper nucleoid. See **Cuprol.**

Copper sulphate. Cupri sulphas. Blue stone. Blue vitriol. $CuSO_4$. This well known salt occurs in deep-blue, transparent, short, odorless prisms, with an acid reaction and an acrid, astringent taste. It dissolves in 2.2 parts of water; 3.5 parts of glycerin. Pencils of the salt may be made by fusing together one part of potash alum and two parts of copper sulphate.

The soluble salts of copper are incompatible with a number of ophthalmic remedies: the alkalies, iodides, lead acetate, lime water, sublimate, silver nitrate, as well as the vegetable infusions and tinctures.

This renowned remedy has recently (and properly) fallen into disuse as a treatment for trachoma and chronic follicular conjunctivitis owing to the pain following its application in the solid form and because we have at our command so many other remedies more humane and equally efficacious. If used at all in this form it should be applied only by the surgeon or someone instructed by him. The crystal or pencil should have a smooth point and the eye ought to be anesthetized with a single drop of a weak (2 per cent.) cocain or holocain (one-half per cent.) solution. The crystal point should now be very gently rubbed over the diseased area, after which the sac should be irrigated with warm sterile water or normal salt solution, followed by the instillation of a few drops of glycerin. This remedy is indicated in trachoma when there is little secretion.

Cupric sulphate ointment (1 to 3 per cent.) made with vaseline, or the glycerin ointment of the German pharmacopeia, is an equally effective and less barbarous method of employing the salt, as is the combination with alum—to make an aluminated copper.

As an astringent eyewater for granular conjunctivitis the following formula is often used: Cupri sulph., gm. 0.5 (gr. viiss); Glycerin; Aquæ dest., āā gm. 10.0 (ʒiiss).

As an ointment: Cupri sulph., gm. 0.1 (gr. iss); Petrolati, gm. 5.0 (ʒj¼).

Hirschberg uses as a menstruum (instead of the foregoing) glycerin ointment to which he adds a little cocain.

A. E. Prince was the first to advise the use of a saturated solution of this salt in glycerine and its subsequent employment in various dilutions for the majority of cases of trachoma. He gives the patient a 10 per cent. mixture of the copper-glycerine in water for home treatment, directing him to dilute it further if necessary. T. A. Woodruff reports a number of cases of trachoma treated in this fashion with the best results.

D. T. Vail, in blepharitis ulcerosa, beats the white of a fresh egg

with a few crystals of bluestone until turquoise-colored curds form. This is applied as a poultice, after thorough cleansing, all night for three nights.

A. Duane advises the use of bluestone as the principal local application for trachoma. As Fuchs says, the presence of corneal infiltrates is an indication and not a contra-indication for its use.

W. B. Anderson prefers the oxy-chloride of copper by electrolysis or cataphoresis. He has found this agent acts more satisfactorily than any other copper salt. The technique is as follows:

Apply to the everted lid, which has been previously cocainized, a copper eye electrode attached to the positive pole of a galvanic battery, using about 3½ milliamperes of current about five or ten minutes. He says, *about*, advisedly, because some patients are more sensitive to this agent than others. Instead of using a milliampere meter he permits the patient to regulate the current by the amount of pressure with which the negative sponge electrode is applied. Experience has taught him that better results are had by brightening the eye electrode before each application. This application is repeated every five days. By this method one does not have the destruction of epithelium that is sustained when copper sulphate stick is used. Moreover, the cataphoretic copper, which is almost as powerful a germicide as bichloride of mercury, penetrates the deeper structures of the lid and reaches every follicle. So efficacious is this measure that the incurable cases are practically nil. He has found it especially useful in the non-inflammatory cases of long standing in which the trachoma follicles are disseminated through the stroma, as in patients of lymphatic temperament. In such instances no other treatment has in any way compared with this in his hands.

Sydney Stephenson (*Trans. Ophth. Soc. of the U. K.*, 23, 1903, 25) has pointed out that a reddish-brown or rusty color of the upper and lower limbus of the cornea may result from the prolonged use of copper sulphate in cases of trachoma.

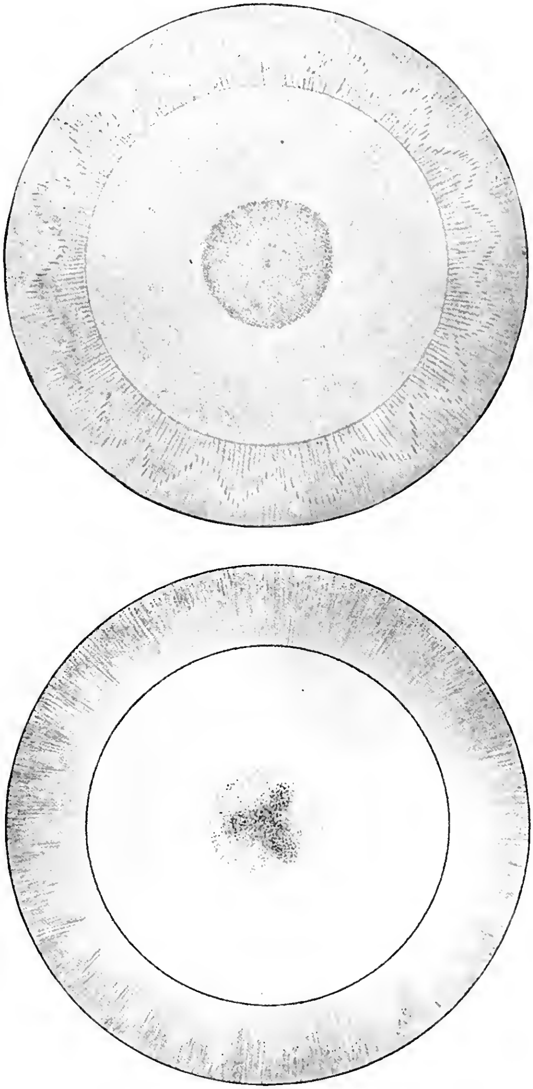
Copper sulphocarbolate. This salt occurs as green, prismatic needles soluble in both water and alcohol. It is not extensively used in ocular diseases but has been recommended in all purulent infections of the conjunctiva as a collyrium in the proportion 1 to 400-200 of water.

Copper verditer. See **Copper acetate.**

Copper-wire arteries. The brilliant, glass-like (ophthalmoscopic) appearance of the retinal arteries in hyaline thickening of the vessels (in which the light streak is intensified) has been properly likened to untarnished copper wire. This condition is best seen in the perivasculitis and engorged vessels attending albuminuric retinitis.

Coppock cataract. Discoid cataract. Nettleship's cataract. Doyne's cataract. This is a rare form of congenital opacity of the lens and may be regarded as a variety of anterior polar cataract. The disc-shaped opacity in the anterior area of the lens is set in a ring of clear lens-substance, giving the appearance indicated by its name.

The story of the discovery of this form of congenital, familial and stationary form of cataract is told by E. Nettleship and Menteith Ogilvie in the *Trans. of the Opth. Soc., U. K.*, Vol. 26, p. 191. The Coppocks and their descendants have lived for many generations in Oxfordshire, England. Of the present population (1500) of Headington Quarry at least 500 are descended from the original John Coppock, who was born in 1774. They are a bright, intelligent race, above the average height and girth, and live longer than their neighbors; and are freer than they of syphilis and rickets. They are thought to have a strain of gipsy blood in their veins. They do not intermarry. Twenty members of the family are known to be affected by the form of cataract that bears their name. The authors say that the "cataract itself, always very partial and circumscribed, is sometimes so slight as to require careful seeking. The patient is often unaware that he has any imperfection of his eyes, and frequently shows no symptom, except liking to shade his eyes against strong light. The opacity takes the form of a *sharply-defined circular disc placed deep in the lens between the nucleus and the posterior pole.* In the great majority the texture of the cataract appears to be uniform, but in one case a triradiate structure is very evident, and two or three others showed slighter indications of this. (See the figures.) The cataract is of the same kind in all cases, but is divisible into minor varieties. It is generally large enough to about block the ordinary—say 4 mm.—pupil. It is always double, and, without exception, accurately symmetrical in the two eyes. The earliest age at which it has been seen is ten years and the latest eighty-two, and the condition seems to be absolutely stationary. There is, however, some reason to think that the cataractous branch of the family has an unusual tendency to presenile lenticular change in the common form of scattered dots and small smudgy striæ. Such changes were noted in at least twelve of the affected division; six of these have also the typical family cataract, whilst of the other six, who have only the scattered changes, three are the adult children of a father who himself has the typical cataract. In three of the above twelve there was also a single, defined, pin-point opacity somewhat deep in the lens, but in front of the typical cataract disc, and placed up and in from the pole; it was limited to the left eye in all three cases. The exact position and nature



Coppock or Discoid Cataract. (E. Nettleship and M. Ogilvie.)

Fig. 1. Typical form of cataract. Left eye of William Coppock, aet. 55 years. Fig. 2. A typical form, showing a triradiate opacity of greater density than the rest.

of the opacity has been a good deal discussed by various competent observers who have seen some of the cases from time to time at the Oxford Eye Hospital, the diagnosis having varied from small lamellar cataract to opacity on the posterior capsule. Ogilvie, who has seen all the cases and studied them with extreme care, believes the opacity to consist of a single layer, always thin, though varying in the degree of its intransparency, situated behind the nucleus but well in front of the posterior capsule. Although the regularity and sharp definition of the outline suggest lamellar cataract, there is never any evidence of a second layer, either complete or in the form of 'riders,' and the term 'lamellar' therefore certainly cannot be used for descriptive purposes. Nor can we suppose that the opaque disc represents a lamellar cataract of which the layers have coalesced after absorption of the centre, for then the opacity ought to lie in the nucleus, whereas both the parallactic test and focal illumination agree in placing it decidedly behind the nucleus; developmentally, therefore, the word 'lamellar' seems a misnomer, unless it should be shown that the part of the lens that is nuclear in early embryonic life becomes post-nuclear at a later stage. Can the opacity result from the persistence of the separate mass of epithelial cells described as existing at the bottom of the lens-cup in early embryonic life?

Visual acuity is not much lowered by the Coppock cataract, being sometimes normal and seldom less than $6/12$, unless from coincident refractive error. There is generally a dislike of bright light, shown by the habit of shading the eyes with the hand when the patient wants to see as well as possible. But, as already mentioned, the inconvenience is so slight that several in whom Ogilvie found the typical opacity refused to believe that their eyes were not quite perfect."

Nettleship (*Oph. Review*, July, 1908) has also exhibited a genealogical tree of 275 persons, of whom 110 were males, 115 females, while of 50 the sex was not recorded. All were descended from 2 brothers, and the chart is divisible into 2 parts, the larger (about 180), containing numerous cases of lamellar and *Coppock (discoid) cataract*, and the smaller 32 cases of cataract and 15 of retinitis pigmentosa out of a total of 150. The presence of these two conditions associated in the same genealogy is doubtless due to each disease having been introduced by different ancestors from independent sources; and the fact that the retinitis pigmentosa is found only in the descendants of one brother inclines one to assume that the taint has been introduced through the wife. The pedigree also shows that Coppock cataract can develop in a child from a parent with lamellar cataract.

De Schweinitz agrees with the advice that in the *treatment* of these cataracts an attempt should be made to dislocate the lens with a needle and permit it to fall into the anterior chamber. See, also, under heading of **Congenital anomalies of the eye**.

Leslie Paton (*Oph. Review,* Jan., 1909) has reported another case, that of a woman, aged 40, who noticed dimness of sight for 20 years. Vision, with correction, was 6/9. In each lens was a small, granular disc, its edges not sharply defined. The patient was not aware of her defect. It was undoubtedly an example of discoid cataract.

Burton Chance also (*Archives of Ophthal.,* Vol. 36, 1907, p. 505) describes five members of a family affected by this peculiar and extremely rare form of cataract. (See the figures.) The family is of German extraction and apparently healthy. The vision was found to be below normal in each case, even after the myopia or myopic astigmatism was corrected. This family consists of a man, his wife, five sons, and one daughter; the persons known to be affected are the father, the third, fourth, and fifth sons, and the daughter. The father has no recollection of his parents having disease of their eyes, though he remembers that they wore glasses in his youth. His father lived to be four-score; his mother was already a widow with one child when she and his father married. By this union there were three sons. The stepsister had bad sight, and one of her five children, a girl, had eye troubles. His two brothers had good sight, but as he has been separated from all his family for many years, nothing positive as to their history can be given. His wife, the mother of all his children, has good sight, and her history is negative. Chance further describes this remarkable family as follows: "The first member I saw was the sixth child, a boy of eleven, who came for the treatment of a black eye. The father said he had noticed that this boy at six could not see as well as the other children could at that age; later he got glasses for him at a jeweler's. Except for an attack of measles and of scarlet fever his health had been good. He was not as tall as boys of his age usually are, neither was he as robust mentally. He made but little progress at school. In bright light the boy appeared dazed, and when wishing to examine objects around him he peered at them. The vision of each eye equalled $5/45$, but with $-1.75 - 4.$ ax. 180 $V = 5/15$. The eyeballs were well-formed and free from external anomalies, while the corneas were clear and the pupils round and mobile. In the centre of each lens was an unusual opacity. This opacity had the form of a sharply defined, circular disk; it was very thin, and placed deep in the lens, apparently between the nucleus and the posterior pole. These disks were about the size

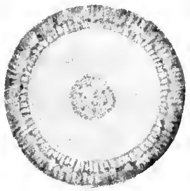


Fig. 1.

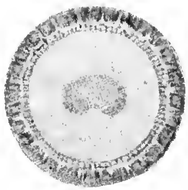


Fig. 2.

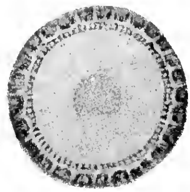


Fig. 3.

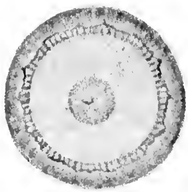


Fig. 4.

Fig. 5.

Discoid or Coppock Cataract. (Chance.)

of the pupillary spaces, being placed symmetrically, of the color of boiled sago, and of a minutely granular consistence. In the right one there were clumps of opacities which reminded me of mitotic figures; in the left there was an indefinite star in the centre, in the sections of which, arranged in a radiating manner, there were the same kind of denser masses as were seen in the right. (Fig. 1.) While the disks were translucent, no details of the fundus could be made out through them, though beyond their circumference the backgrounds could be studied perfectly, for the peripheral portions of the lenses were quite clear. The retinas and choroids were well preserved for so marked a grade of myopia. No uveal anomalies were seen and no evidences of rachitis found. I noticed that the boy's father also peered about while finding his way in the darkened room. He allowed me to examine his eyes and to my surprise I saw opacities in the lenses similar to those found in his son's. He is a railway engineer, and he rather resented the suggestion that his sight could be defective. He is moderately myopic and wears glasses when reading. The cataract in his right eye was reniform, with the hilum on the lower border; that in the left was almost circular having a flattened base. Each was as though a film of sago-like substance had been placed behind the pupil, which on magnification was seen to be homogeneous and finely granular. (Fig. 2.) The third son, aged 20, is a machinist, and has good sight. Deep in his right lens was a dense, opaque clump in the nasal half of a faint circular disk; while in the left there was a disk of such extraordinary thinness as to be scarcely detected—it might have been likened to a simple condensation of the crystalline substance. (Fig. 3.)

"The daughter, a healthy rosy-cheeked girl of 16, also had disks in her lenses; that in the right was studded with tiny dots, and in the centre was a dense opacity. In the left one were several clumps with fine dots about them. (Fig. 4.) Her vision was only $4/60$, in the right, and $5/30$, in the left eye, but this was due to a general myopia of four dioptres. The fourth son, a boy of 13, a myope whose vision was $5/15$ in the right and $5/30$ in the left, also had disks in his lenses. In his case they were dot-like in consistence, but irregularly arranged; in each were six distinct circular vacuoles. (Fig. 5.) These cataracts were partial and circumscribed and they could be seen only by using strong lenses in the ophthalmoscope. They were of the same kind in every case and they were large enough to block the usual pupillary spaces. When the pupils were dilated the opacities shown out and measured about four millimetres in diameter. In each person they were double and without exception accurately

symmetrical in the two eyes. They appeared to be stationary. The exact position of the opacities was hard to define. They were not polar, neither were they nuclear, but they seemed to lie between the nucleus and the posterior pole."

Copula nervorum opticorum. (L.) Optic chiasm.

Copyopsia. The same as copopsia or copiopia. (q. v.)

Coque oculaire. (F.) The membranes of the eye (sclerotic, choroid, retina, etc.) considered as a whole.

Coqueluche. (F.) Pertussis. Whooping cough.

Coquilles. Shell-shaped (hence the name) glasses, generally tinted and used as a protection to the eye.

As protective spectacles come into more general use to modify light, and to guard against dust and wind in automobiling, etc., the question of their proper form increases in importance. John Green points out that coquilles afford more complete protection to the eyes, and cause less displacement of objects seen through their periphery. When of moderate curvature and thickness they may be regarded as practically of zero power. If, however, they are thick and strongly curved, and have their surfaces concentric, they act as concave lenses. On the other hand, if the two surfaces are ground of the same curvature the glasses are thicker toward the periphery and cause more displacement of objects seen through that portion. By mathematical demonstration of their action on light, Green arrives at the conclusion that to obtain coquilles of practically zero power the concave surfaces should be slightly flatter than the convex, the difference in the length of the radii being one-third the thickness of the glass at its centre. Casey Wood, finding the coquilles in the shops unsatisfactory, avoids these mathematical problems by advising that protective glasses be always plane.

Coral. Recommended by Dioscorides, the greatest materia medicist of antiquity, for corneal ulcers. Coral, by the way, was supposed by the Greeks to be a plant; hence the name, "Lithodendron," or "stone-tree."—(T. H. S.)

Coralliform cataract. Fusiform cataract. Axial cataract. It is generally congenital, or shows itself early in life, is often hereditary and resembles the lamellar variety. When of the transmitted type it frequently affects successive siblings; more often the first born. Nettleship gives one extraordinary pedigree of five generations containing more than ninety individuals, thirty of whom are known to have had cataract. From the history, the cataract must have been congenital in every case and probably due to intrauterine changes.

Corax. (L.) Aegilops. An obsolete term to denote a lachrymal fistula, or an abscess of the sac that has opened externally.

Cordia rotundifolia. A Peruvian species, a decoction of whose leaves is employed in ophthalmia.

Cord, spinal, Eye symptoms in diseases of the. This important subject is fully discussed under the major heading, **Neurology of the eye,** as well as under such minor captions as **Tabes dorsalis**; **Cerebro-spinal meningitis**; **Infantile paralysis,** etc.

Coré. (F.) The pupil.

Core. (L.) The pupil of the eye (originally, the eyeball).

Coréclise. (F.) Corocleisis.

Coréclisis. See **Coroclisis.**

Corectasis. (L.) Dilatation of the pupil.

Corectenia. (L.) (Obsolete.) Enlargement of the pupil by prolapse of the iris through a wound in the cornea.

Corectodialysis. (L.) Iridectomy and iridodialysis.

Corectome. An instrument used in iridectomy.

Corectomia. (L.) Iridectomy or iridodialysis.

Corectomodialysis. (L.) Iridectomy or iridodialysis.

Corectomy. Iridectomy.

Corectopia. (L.) A condition in which the pupil is not in the centre of the iris. Often the pupil is found slightly eccentric, but marked displacement is very rare. It is usually an accompaniment of ectopia lentis. The displaced pupil is often small, irregularly circular or slit-shaped, and inactive. It may be associated with the presence of granular opacity and blood-vessels on the lens, as in a case reported by de Beck. This subject is fully discussed in Vol. IV of this *Encyclopedia,* under the heading **Congenital anomalies of the eye.**

Coredialysis. Iridodialysis. Detachment of the iris from the ciliary body.

Corediastasis. (L.) Dilatation of the pupil.

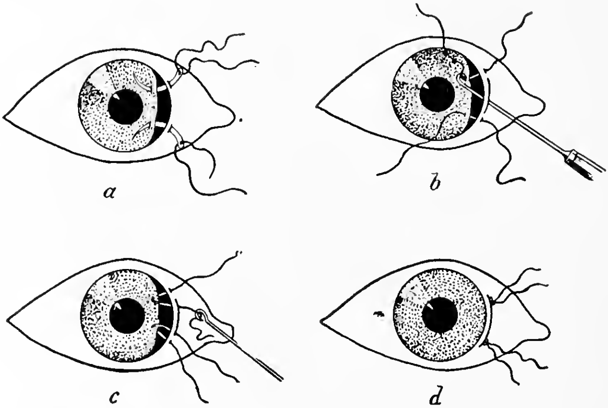
Corediastole. (L.) Dilatation of the pupil.

Corelysis. (L.) Iridolysis. Sphincterolysis. The operation of detaching the pupillary or sphincter margin of the iris from any adhesions which it may have contracted to the cornea or to the capsule of the lens. The aim of this operation is the freeing of the pupillary margin of the iris, when in consequence of iritis this has become adherent posteriorly to the anterior lens capsule, or by a traumatic or ulcerative perforation of the cornea anteriorly to this latter membrane.

Such operations were formerly considered of great importance, since it was thought that the pulling on the iris or ciliary body due to such

adhesions when the sphincter or the ciliary muscle were contracted, was the sole cause of pain and irritation, glaucomatous conditions, lack of accommodative power, and even of purulent inflammations, as are sometimes observed in such cases. In the light of better knowledge we must assume that at least the inflammatory symptoms are primarily due to the entrance into the iris tissue of some infectious germs, probably by way of the scar. When the scar is a solid one, this danger is but small.

On the other hand we know that the freeing of the adhering iris in eyes which are in a chronic state of irritation is often followed by considerable improvement.



Jameson's Reattachment in Corelysis, Showing the Various Steps of the Operation.

Although Wenzel and Beer had already attempted posterior iridolysis with a sharp hook in cases in which the lens was cataractous, Streatfeild was the first to perform this operation in eyes with a clear lens. In this he was soon followed by Weber. These operators made a corneal incision near the centre of the cornea, or even at it, the choice of the position, however, being determined by the situation of the synechia or synechiæ. Streatfeild attempted not to let the aqueous humor run out. Then he entered the anterior chamber by means of a fine spatula, really a small knife, and tried to break the adhesion without injury to the lens capsule. Weber, on the other hand, purposely emptied the anterior chamber, then entered the eye with a small, flat hook which was introduced between the iris and lens. By very careful manipulation thus the posterior synechia was broken. Aside from the danger of wounding the lens, this operation very often proved useless either because it was impossible to sever the adherent tissue or the synechiæ would recur.

Passavant did not attack the synechia directly, but after having made a small and oblique corneal incision in the meridian in which the synechia was situated, entered the eye with a forceps, grasped the iris as near the adhesion as possible, and carefully pulled it off from the lens.

Streatfeild's Spatula for Corelysis.

Walker having dilated the pupil at maximum entered the anterior chamber with a cutting needle at a point in the corneo-scleral junction opposite to the adhesion. The needle having been passed very carefully between the iris and lens capsule, the iris was engaged by it and lifted off the lens toward the cornea, and by lateral movements the adhesion was broken. The important point in this operation was the retention of the aqueous humor in the anterior chamber, even after the withdrawal of the needle. As far as the danger to the lens capsule is concerned, the sharp needle is, perhaps, more dangerous than either Streatfeild's spatula or Weber's flat hook.

In modern times these operations for posterior iridolysis are rarely even attempted, iridectomy having taken their place.

After cataract extraction with iridectomy when the lower pupillary margin had become adherent to the lens capsule, the writer has, in a few cases, instead of making a capsulotomy made a small peripheral incision downwards, entered a Tyrell's hook and gently loosened the pupillary margin from the lens capsule. In this manner a clear pupil was obtained and the insidious upward movement of the iris toward the corneal scar was obviated.

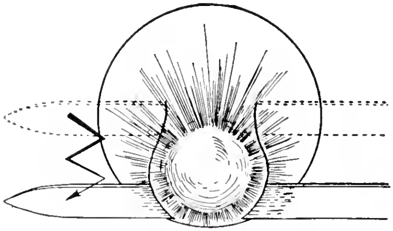
Weber's Hook for Corelysis.

Anterior iridolysis has for its aim to free the iris which may have become adherent to the cornea after an operation, or an ulcerative or a traumatic perforation. Such an adhesion may have the shape of a small thread only, or be broader, or it may even concern a large portion of the iris, as is usual in adherent leucoma and in corneal or corneo-scleral staphyloma.

The operation, if successful, removes the attachment of the iris and has a beneficial influence on the bad condition due to it, and may open up a useful pupil.

Numerous operative measures have been devised by different operators and numerous different instruments have been recommended for their performance. Yet every case will have to be studied and handled on its own merits.

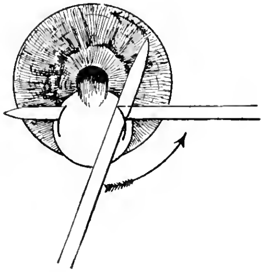
Bowman, having made a small corneal incision, entered a blunt-pointed Weber's lachrymal knife and cut the iris off the corneal scar by pressing the edge of the knife against the latter.



Abadie's Staphylotomy.

Meyer used a small sickle-shaped knife and cut the adhesion in the direction from the cornea toward the pupillary margin.

Kerschbaumer is reported by Schulek to have used a narrow von Graefe knife for the same purpose.



Schulek's Sphincterolysis Anterior.

Walker also used a von Graefe cataract knife with which he entered the cornea peripherally at a point opposite to the synechia. By sweeping lateral movements he cut the adhesion without allowing the aqueous humor to escape, until the knife was withdrawn.

Lang used two Knapp's knife-needles, one with a sharp point, the other with the point rounded off. With the pointed knife-needle he pierced the cornea at a point lying sufficiently far to the side of the corneal scar, so that the blunt knife, being entered after the quick withdrawal of the first one, could be easily introduced between the iris and cornea. With this second knife, the aqueous humor not

having escaped, he could then easily cut the adhesion off. The chief difficulty seems to have been to find the small opening of the first knife-needle to enter the second one through it, though this defect in the technique is somewhat lessened by making it over or in front of a plainly visible scleral vessel.

Others have used de Wecker's pince-ciseaux successfully to cut off such anterior synechiæ.

For more complex cases with partial corneal staphyloma Abadie devised a procedure which he called staphylotomy. The aim of this operation is to free the iris from the base of the staphyloma. The operation is performed by a von Graefe knife which enters the cornea, in case of a corneo-scleral staphyloma, near the scar tissue, and is passed through what anterior chamber may be left, between cornea and iris. Now, with a sawing movement, the iris is cut off from the base of the staphyloma parallel to the cornea. Near the corneo-scleral margin the knife is withdrawn without cutting through the corneo-scleral tissue. In an ideal case of this kind the previously tense iris is cut off from the base of the staphyloma and retracts at once.

In cases in which no anterior chamber exists, Abadie goes at once with the knife through both cornea and iris and passes through the posterior chamber, making a counter-puncture symmetrical to the point of entrance on the other side of the staphyloma. Then, with a sawing motion, the iris is cut off the base of the staphyloma by cutting parallel with the cornea to the corneo-scleral margin.

Schulek, using a knife-needle with a convex edge, entered the cornea with the knife on the flat, so as to cut one side of the adhesion by turning the cutting edge toward the cornea. He then passed the knife through the pupil behind the iris and cut the other side of the adhesion.

Another method, called by Schulek sphincterolysis anterior, aims at freeing the pupillary edge of the iris alone. He entered a narrow von Graefe knife on the flat within the scar tissue and tangentially to one limb of the adherent sphincter edge. Then he turned the handle around an angle of 100 to 120 degrees and in this manner placed the edge of the knife in such a position that both limbs of the anterior synechia could be cut at the same time by making a counter-puncture and cutting, with a sawing motion, toward the corneo-scleral margin. The flap could be left unfinished by withdrawing the knife, or completed, as the case might demand.—(A. A.)

Coremegine. An obselete name for atropine.

Coremetamorphosis. (L.) Irregularity in the shape of the pupil.

Coremorphoma. (L.) Coromorphoma. Coromorphosis. Artificial pupil.

Coremorphosis. Operation for artificial pupil in general.

Corencleisis. Another spelling of corenclisis (q. v.)—an operation for artificial pupil.

Corenclisis. The formation of a new pupil by displacement, the iris being drawn aside and in part excised.

Coreometer. Pupilometer. An instrument for measuring the diameter of the pupil; several varieties of instruments for this purpose have been proposed by Obers, Follin, Lawrence, Coccius, Galezowski, Obernier, Fick, Hondin, Badal, Mulder and Kreuchel, Doijer, and Landolt. One of the earliest and simplest is the instrument of Lawrence, which consists of a horizontal scale divided into quarters of a line. This scale carries two vertical indices, one of which is stationary while the other can be moved along the scale by means of a screw. (Foster.) See, also, **Examination of the eye**; as well as **Pupilometer.**

Coreometry. The measurement of the pupil of the eye.

Coreoncium. (L.) Coreoncion. (Obsolete.) A hook-like instrument, devised by Langenbeck, for drawing out a portion of the iris through an incision in the cornea, to form an artificial pupil. It was also applied to forceps with double hooks, invented by the elder von Graefe.

Corepalinanoixis. (L.) An obsolete term for the re-opening or re-establishment of the natural pupil.

Coréparelcyse. (F.) The formation of an artificial pupil by elongation.

Coreparelcysis. (L.) (Obs.) An optical iridectomy. See **Coroparelcysis.**

Corephthisis. (Obsolete.) Habitual contraction of the pupil.

Coreplasty. A term, now rarely used, to indicate the formation of an artificial pupil; coremorphosis.

Corespace, The. According to Sachs (*Archiv f. Augenheilk.*, Vol. 18, p. 42) the position of a typical oval scotoma, lying as it does eccentrically and to the outer side of the fixation point, becomes of prominent importance in that the corresponding parts of the retina the finer qualities of the visual sense are often destroyed. During the period of recovery the last remnants of the scotoma may be demonstrated when the centre suffices for all demands, as regards color- and space-sense, that ordinary clinical methods of examination require. This area, which is fully described by Sachs, extends in a horizontal direction from one or two degrees to about eight degrees

laterally from the fixation point. Its extent of vertical direction generally nearly coincides with the horizontal. In this space it is easiest for all absolute scotomata to appear, and it is the situation in which the scotomata shrink as they gradually lessen during the stages of recovery from amblyopia. The area itself is situated between the fixation point and the peninsula already alluded to, giving the scotoma its horseshoe-shape during the beginning of the disease. Uhthoff calls attention to this space (*Archiv f. Ophth.*, Vol. 33. 1, 307). As there may be visual acuteness of 6/8 at the centre of the field, and yet a small red object completely disappear at this point, Bunge, in order to make a rapid diagnosis of such a color-scotoma, places two red surfaces on the bow of the perimeter, so that one is eight degrees on the nasal side and the other the same number of degrees on the temporal side of the fixation point. This done, he makes the patient simultaneously compare the two color-areas whilst central fixation is carefully preserved. The lateral position of the "corespace" also demonstrates the almost constant observation that the right eye finds difficulties in reading print, which runs together, because a large part of the letters of a long word falls on this space of the scotoma. Hence also can be understood why there should be difficulty in seeing near objects when distant ones are distinct. Moreover, it can be seen, on account of the lateral position of this space, why vision in the left eye fails in passing from the end of one line to the beginning of another when reading, and often for the first letter of a word. (*System of Diseases of the Eye*, Vol. 2, p. 255.)

Corestenoma. An obsolete, or rarely-used, term employed to describe a partial closure of the pupil. The most common form is congenital corestenoma, caused by proliferations or outgrowths from the sphincter margin of the iris, which sometimes touch each other and thus form several pupils. See **Congenital anomalies of the eye.**

Coretodialysis. COREDIALYSIS. A name for iridodialysis.

Coretomodialysis. (L.) An old name for iridectomy, or iridodialysis.

Coretomy. Iridotomy or iridectomy; any surgical cutting operation on the iris.

Coretonectomy. A rarely used synonym of iridectomy.

Coretotomy. A rarely used synonym of iridotomy.

Coriander. CORIANDER SATIVUM. Used by all the ancients as an ocular anesthetic, and, by the Greeks and Romans, as a remedy for epiphora. It was generally mixed with mother's milk.—(T. H. S.)

Corinanthe johimbe. From the bark of this West Indian tree the local anesthetic alkaloid *johimbin* (q. v.) is derived.

Corium of the cornea. A term used in the embryology of the eye to indicate the division of one of the mesodermal blastomas.

Corkscrew vessels. A name given to the central artery of the retina and its branches in certain congenital and acquired local and general vascular conditions. Dor (*La Clinique Ophtal.*, Dec., 1911, p. 620), suggests that the corkscrewing of the retinal vessels may not only be a local congenital anomaly, but may be an acquired anomaly indicative of an exaggerated tortuosity of the vessels throughout the body. While the condition is a rare one, it is sufficient to have seen it once to always recognize it. In some fundi the tortuosity is so great as to give one the well-known picture of the head of Medusa. There is never any sign of varicosity, no adjacent edema of the retina, nor change in the appearance of the blood. No observer has ever seen this condition develop in a fundus which formerly presented a normal appearance. In arterio-venous aneurism, corkscrewing has been seen, but this was limited to a branch of the central vein. In three cases of Wagner's disease *(polycythemia megalosplenica)* there was pronounced tortuosity of the veins, and a lesser one of the arteries. In leucocythemia a similar tortuosity has been observed. These observations would lead one to suspect an alteration of the blood in all cases of corkscrewing, but the findings are not such. Levin has found the composition of the blood normal in a case of exaggerated tortuosity, and the only explanation to offer is that a blood anomaly had existed and subsided, leaving the consequent tortuosity of the vessels as a permanent change.

Levin thinks there may be some connection between tortuosity and hypermetropia, but this is disproved by Gloorn observing a typical case of tortuosity in a myope, and Dor in an astigmatic subject. The subjective symptoms are very slight; the subjects complain of temporary obscurations, they cannot stand prolonged use of the eyes, sometimes there seems to be a pressure in the eyes, but, all in all, there is little discomfort, and the visual acuity is generally good. This would seem to prove that there cannot be any serious concomitant nervous trouble. In one case Wilbrand observed facial tic, insomnia, and cardiac palpitation.

Cornea. Of this, perhaps the most interesting and important of the external coats of the eye, an account is given on page 368, Vol. I of this *Encyclopedia.* See, also, **Development of the eye** and, for further information regarding its structural relations, **Histology of the eye.**

A number of corneal diseases will also be found under **Keratitis** headings.

Cornea, Abscess of the. Onyx. Hypopyon keratitis. Suppurative keratitis. This is an occasional result of infective ulcer; and usually associated with the serpent, creeping or spreading variety, while hypopyon and iritis are almost invariably present. It is attended by severe pain, photophobia and blepharospasm, with much circumcorneal injection and tenderness. An abscess situated in the deeper layers of the cornea (onyx) is, strange to say, less likely to result in ulceration than a more superficial abscess, while absorption of its contents occasionally takes place.

Treatment.—Atropin and hot applications should be used, but if the abscess shows a tendency to spread or to go on to ulceration, treatment of a more active nature should be substituted. An incision should be made into the abscess cavity and its walls thoroughly scraped or cauterized (or both procedures adopted) and treated as a sloughing ulcer.

In addition to the operative treatment irrigations with 1 to 10000 of hot formalin solution will be found of considerable value; as well as subconjunctival injections of mercuric cyanate. See, also, **Keratitis, Suppurative.**

Foroni (*Ann. di Ott.*, Vol. 42, p. 490, 1912) proposes keratectomy for the treatment of hypopyon keratitis. The abscess is circumscribed with the point of a knife held vertically and falling on healthy corneal tissue. At the inner margin of the incision the circumscribed area of the cornea is seized with the forceps and the diseased tissue completely dissected away from the rest of the cornea, avoiding exposure of Descemet's membrane or entrance into the anterior chamber. The exposed surface is then scraped under continuous irrigation, especially at the margins, after which the operative field is irrigated with bichlorid or oxycyanid of mercury solution. The lids are sealed with adhesive. The violent inflammatory symptoms, from which the eye previously had suffered, are said to cease within twenty-four hours after the operation; and the resulting opacity is minimal in amount. Twenty-nine cases are reported, with the best results. The operation was suggested by Wiener (*Trans. Chicago Ophthalm. Soc.*, 1911).

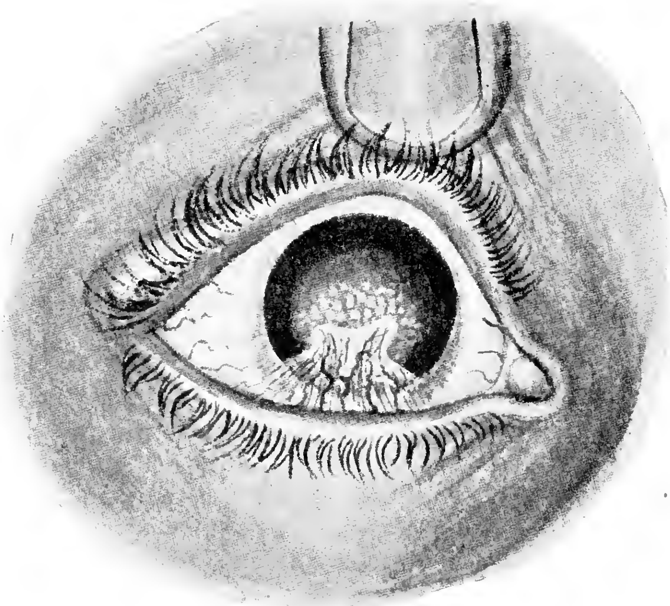
Cornea, Acne of the. See **Cornea, Acne rosacea of the.**

Cornea, Acne rosacea of the. This disease of adult life is most commonly seen in women. It usually occurs in connection with the same condition of the skin of the face or the conjunctiva.

Acne rosacea usually affects the middle two-thirds of the facial skin, and is chronic in character. The congestion, according to Crocker, is confined to the deeper vascular layer of the corium, which is later followed by new-vessel and connective-tissue formation and

changes in the sebaceous glands, all of which he considers are brought about by vaso-motor reflex neurosis. Pusey believes it to be an angioneurotic affection appearing as a chronic reflex flushing of the face.

The clinical picture is very like that of phlyctenular keratitis, but as acne rosacea of the cornea is a disease confined to adults and usually associated with a similar condition of the face, the two conditions are readily differentiated. The lesions are usually subepithelial and do not, as a rule, penetrate deeper than the anterior



Acne Rosacea of the Cornea. (Holloway.)

layers of the corneal lamellæ. The infiltrate is grayish in color and the cornea at the site of the papule is slightly elevated. The nodules, which appear above the corneal margin, have the appearance of eczema pustules (Haab). Permanent opacities of the cornea remain at the site of the affected areas and, in severe and protracted cases, the opacity may cover the entire cornea. Holloway (*Arch. of Ophthal.*, Vol. XXXIX., No. 4) carefully studied a case of acne rosacea in a woman of twenty-nine years. She had had two previous attacks, the first about three years prior to the one which was reported. The lid and its margin were covered with small, ulcerated patches. In the lower

quadrant of the cornea there was a superficial, dense, grayish-white infiltrate extending from the limbus almost to the middle of the cornea. The surface of the infiltration was slightly elevated and numerous vessels were present; at the apex of the inner spur a small ulcer appeared. The entire cornea was distinctly hazy with several grayish, punctate infiltrates in the upper and outer portion. The lower limbus was occupied by several small, phlyctenule-like elevations. This patient had mild acne rosacea of several years duration. See the illustration.

Redness of the lids and conjunctival congestion, with isolated episcleral nodes, usually accompany the corneal involvement. Lachrymation and intense photophobia are always present.

Acne rosacea of the cornea is very rebellious to treatment, and the disease is prone to relapse. The most effective remedial agents are holocain, dionin, calomel, yellow oxide of mercury and massage; or the galvano-cautery. Radium has also proven an effective treatment for this disease.

Verhoeff has found in holocain an agent which has proved most effective in the treatment of this disease.—(J. D. L.)

A case of corneal acne is described by Goldsmith (*Practical Medicine Series*, p. 40, 1908) in a man of forty with well-marked acne rosacea extending over the nose and cheeks. The patient developed an inflammatory condition of both eyes of a recurring type, which finally resembled the facial eruption. The corneæ were involved by opaque interstitial opacities, which extended to the center of the corneæ and terminated in a definite excavation. A leash of blood vessels ran in from the periphery. There was no iritis. The conjunctival inflammation was severe, and photophobia was intense.

In one instance detailed by Darier (*La Clinique Ophtal.*, Vol. IV, No. 1) the bulbar mucous membrane showed more or less congestion, with episcleral nodes, that disappeared completely after several weeks. These were gray in color and not transparent. Millet-seed-sized nodules appeared in the subepithelial layer of the cornea, penetrating into the parenchyma. These exudates are absorbed but always leave opacities accompanied by vascularization, and in certain cases have a reflex resembling cholesterin. Iritis is rare. Subjective symptoms are variable, with neuralgic pains so intense that radium furnishes the only relief in some cases.

Darier has not tried holocain instillations, but had best results with dionin, followed in an hour by gentle massage with yellow oxid or scarlet-red salve. Constitutional remedies are needed, as milk diet and alkaline waters. For the face lesions a ten minute massage with

finely powdered turbith (gr. iv in benzoated lard gr. xxx) left on over night. Radium applications for the pain, and iridectomy for optical reasons are necessary at times.

Cornea, Actinomycosis of the. This is an exceedingly rare disease. K. Orloff (*Viestn. Oft.,* September, 1912) reports two cases seen by him. In one the source of infection was dirt from a horse's hoof; in the other the sweepings of a hay-loft. The cases were not seen until six weeks after the accident. In the first case a light brown prominence 2 mm. in extent was removed with a sharp spoon and the base treated with tincture of iodine. Healing was rapid and uneventful. In the second case there was a deep ulcer with bright red borders conical in shape. This did not heal so satisfactorily as the first case, a definite opacity being left. Bacteriological examination showed in both cases the presence of the same species of actinomyces, which the author proposes to call *actinomyces purpureus* on account of the purple pigment it rapidly produces. See p. 84, Vol. I of this *Encyclopedia.*

Cornea, Anesthesia of the. Apart from the local action of such agents as cocain, apomorphine, holocaine, etc., diminished sensibility of the cornea may result from a large number of diseases, local and general, e. g. hysteria, coma, Basedow's disease, paresis or paralysis of the fifth nerve, glaucoma, pemphigus of the cornea, etc. See, also, under heading of **Cornea, Sensibility of the.**

In *hysteria,* the phenomenon usually occurs in young nervous subjects who manifest other symptoms of hysteria. The cornea may be partially or wholly insensitive, but according to Gilles de la Tourette it is only in exceptional cases that the central portion of the cornea loses its sensibility, the anesthetic areas being usually restricted to the inner or outer portions of the cornea.

Féré, in studying this phenomenon, observed in cases where the corneal anesthesia was complete that the condition was associated with a defective oculo-palpebral reflex.—(J. D. L.)

In *glaucoma* the insensibility is generally attributed to compression of the nerve fibres going to the epithelium by the fluid in the lymph spaces around them, as they pass forward through channels in the anterior limiting membrane. It is more likely to be due to compression of the long ciliary nerve, from which the corneal nerves are derived, against the hard, unyielding sclerotic as they pass forward on the outer surface of the choroid. See **Cornea, Reflex of the**; as well as **Cornea, Sensibility of the.**

Cornea, Annular ulcer of the. See **Cornea, Ring ulcer of the.**

Cornea, Argyrosis of the. This condition is not infrequently seen during or after the use of argyrol in ulcer of the cornea. In a case

reported by Marquez (*La Clinique Opht.*, 10 Dec., 1908) there was almost complete opacification of the cornea in both eyes, due to repeated instillation of 5 per cent. silver nitrate. Marquez thought the opacities were due to chloride and albuminate of silver, and sought to dissolve these incrustations by the use of a solution of hyposulphite of soda.

Having cocainized the cornea to such an extent as to soften the epithelium, he carefully scratched the surface of the cornea with the back of a Graefe knife, taking care not to go deeper than the epithelium. The eye was then held in an eye bath containing a solution (strength not mentioned) of hyposulphite of soda for ten minutes, and this bathing was repeated three times during a day. The author says that the eye must be well cocainized, as the first baths are very painful. From the first days there was notable clearing of the right eye, which was alone treated, the left remaining absolutely opaque. The left eye was then treated in the same manner, with like results. Never before has Marquez seen opacities of this sort clear in such a marked manner, and he thinks that the action of the hyposulphite of soda deserves further study.

Cornea, Arthritic ulcer of the. See **Cornea, Dendritic ulcer of the.**

Cornea, Aspergillus ulcer of the. This form of micotic ulcer of the cornea may be due to several species of mold, Aspergillus.

Zentmayer (*Ophthalmic Record*, April, 1912) exhibited the culture and microscopic specimen from a case of aspergillus flavescens infection of the cornea. He said that of the many varieties of the aspergillus the *fumigatus* was the variety usually found in corneal lesions due to the mold fungi. Other forms are the *flavus, glaucus,* and *niger.* The fumigatus is the most virulent. The case is, therefore, of particular interest because the ulcer was due to infection by one of the rarer forms. The patient, a man aged twenty, stated that two days before he had gotten a foreign body in the right eye.

There was a superficial ulcer of the cornea not more than 1.5 mm. in diameter, yellowish in color, with a small, black, central dot. Connected with this, but at a much deeper level, there was a small, irregular area of denser infiltration. The edges were well-defined, but with the loup the surrounding corneal tissue was quite hazy. There was neither hypopyon nor vascularity, but a good deal of irritation and lachrymation and moderate peri-corneal injection. The culture showed a soft, furry, white coating on the media, which microscopically was found to be due to the *Aspergillus flavus vel flavescens.* The ulcer was curetted, and Ewing's solution and iodin applied.

According to Fuchs the clinical picture of mold ulcer differs from

ordinary ulcus serpens. There is first a central corneal infiltrate which later undergoes superficial disintegration, distinguished by its dull, crumbly surface. About this area a gray or yellowish annular line of demarcation forms which gradually deepens into a gutter and leads to an exfoliation of the inclosed portion of the cornea, which in the meantime has become necrotic. Hypopyon is usually present. According to Leber, there is besides this severe type a second milder form characterized by a circular, grayish-yellow, dull patch separated from the uninvaded cornea by a shallow groove, the surrounding cornea being slightly infiltrated. A leash of vessels may lead up to the ulcer from the limbus nearest to it.

Ball states that probably locality has nothing to do with its frequency, as one country physician near St. Louis met with seven cases in two years.

Cornea, Astigmatism of the. Astigmatism due to an irregular contour of the cornea.

John Rowan (*British Medical Journal*, January 13, 1912) reports 500 cases, or 1,000 eyes, in which the astigmatism was measured, first, by the ophthalmometer of Javal and Schiötz, and then by retinoscopy, with atropin or homatropin cycloplegia. His results are as follows: Out of 1,000 eyes examined, the *total astigmatism and the corneal astigmatism* were the same in 475 cases, that is, 47.5 per cent; 230 were hypermetropic; 353 showed compound hypermetropic astigmatism; 89 were myopic; 190 showed compound myopic astigmatism; and 138 mixed astigmatism. The divisions into the different classes were made by the actual figures made by retinoscopy. See page 656, Vol. I of this *Encyclopedia*.

Cornea, Atheromatous ulcer of the. In old corneal ulcers, especially those which are thick, and sometimes in staphylomatous conditions, there occurs a regressive metamorphosis, which consists in the formation of hyaline masses and the deposition of lime salts, from which may develop atheromatous ulcers, following mechanical injuries and bacterial invasion. As scar tissues of the cornea are not possessed of normal nourishment, they are prone to primary necrosis, which may be either superficial or deep. When deep, perforation frequently results, which may terminate in panophthalmitis by extension to the interior of the eye. These complications are especially liable to occur when ulceration accompanies a scar located at the apex of a corneal staphyloma. In atheromatous ulcers, the necrotic tissue is cast off as sequestra. They are sometimes thickly coated with pus, and small calcareous particles may be seen lying loose on the floor of the ulcerating area.—(J. D. L.)

Cornea, Band-shaped affection of the. Band-shaped keratitis. See page 877, Vol. II, of this *Encyclopedia.*

Cornea, Blood-staining of the. This is a rare condition which develops secondary to subconjunctival hemorrhage, when it occurs close to the corneal limbus, or when the anterior chamber is filled with blood (hyphemia) for a long time. In cases due to subconjunctival hemorrhage, only the corneal periphery in proximity with the subconjunctival hemorrhage becomes stained. Hyphemia results from injuries, operations, and, in a few instances, it has been observed spontaneously in old cases of retinal detachment. In protracted cases of hyphemia, a corneal stain may result from the hemoglobin that is released. The latter enters the corneal stroma by diffusion through Descemet's membrane, the pigment crystals (chiefly hematoidin) being deposited in the corneal lamellæ. The appearance of the stained cornea varies greatly, the opacities assuming a brownish, reddish, or greenish-black hue, influenced by the duration of the staining. The periphery of the cornea, in these cases, remains clear, the unaffected zone measuring from one to one and one-half mm. This condition may be clinically confused with an amber lens dislocated anteriorly. Increased intraocular pressure is probably always present in the early stages. The opacities begin to disappear at the periphery, but rarely does the cornea regain its normal transparency at the center when the absorption is delayed for any considerable length of time.

The opacification may disappear in two months, but instances where resorption has been delayed for two years, or longer, have been reported. The pigment deposits are found between the fibres of the substantia propria and, according to Treacher Collins, are in the nature of hematoidin or hemosiderin, which do not contain iron. Parsons states that hematoidin contains no iron, yet the deposits often give reactions for iron.

The only *treatment* recommended for this condition is dionin and moist heat. See, also, **Cornea, Melanosis of the.**—(J. D. L.)

Cornea, Bullæ of the. Bullous disease of the cornea may mean certain forms of herpes, papular disease, also pemphigus. These lesions will be described under their proper headings.

Cornea cacuminata. (L.) Staphyloma of the cornea.

Cornea, Calcareous degeneration of the. Calcareous keratitis. This is an affection characterized by the deposition of lime salts (usually carbonates and phosphates) in the corneal tissues of old, dense scars, mostly in shrunken eyes which have been destroyed by cyclitis or glaucoma. It has also been observed in the eyes of elderly people as a primary deposit. The condition is usually the culmination of

previous inflammatory conditions, the pathological process terminating in a series of degenerative changes, very often hyaline at the beginning and ultimately becoming calcareous (Leber and Sachsalber). It is, therefore, notable that these formations occur in corneal tissues whose vitality has been lowered by a previous pathologic condition. In some cases the opacity develops from two foci—one on either side of the cornea—which are separated from the limbus by a narrow area of clear tissue. From these two points, the slowly-developing opacities approach each other after several years and unite, being less dense at the corneal center. The band-like film is situated a little below the palpebral fissure, slightly concave above and nearly straight below.

The deposition of lime salts is confined to the superficial corneal layers, i. e., Bowman's membrane and the superficial lamellæ. Bowman's membrane becomes broken, calcareous deposits accompany the new-formed blood vessels and neoplastic connective tissue appears, probably as the result of the irritation produced by the deposits.—(J. D. L.)

An interesting case of calcareous degeneration of the cornea and lens capsule in a patient who had injured his eye one and a half years previous to admission to the hospital is reported by Tooke (*Arch. of Ophth.*, January, 1913). A round, dense scar covered the center of the cornea and a chronic glaucoma was present. Examination of the enucleated eye showed the anterior capsule of the lens to be of the appearance and consistency of an eggshell and clinical tests showed it to be calcium carbonate. Examination of sections of the cornea showed similar calcareous changes. Tooke believes the condition present in lens capsule and cornea to be a primary degenerative process not preceded by previous inflammatory alterations. See, also, page 1355, Vol. II of this *Encyclopedia;* as well as **Cornea, Lime incrustations of the.**

Cornea, Capsular portion of the. Pars scleralis corneæ. A name for or division of the corneal structures, including the anterior limiting layer and the cornea proper.

Cornea, Carcinoma of the. W. H. Dudley (*Ophthalmic Record,* Vol. 16, p. 231, 1907) gives an account of this extremely rare neoplasm. The patient, aged 83, came with a vascular macula of the cornea, extending from the inferior temporal quadrant of the limbus upward and inward, just covering the pupil, which was small. The unaffected portion of the cornea and the iris appeared normal, as well as the remaining portions of the eye not covered by the corneal opacity. Examination further showed that the scar tissue, while extending to

and including the limbus, did not implicate the sclera to any degree. A portion of this was removed and sections made which were pronounced, by a competent pathologist, to be papillomatous. Three months later (June, 1895) the growth had recurred and another piece, which measured 6x9x3 mm., was removed. Sections of this, like the former, were considered by the pathologist to be part of a papilloma. In September of the same year the growth recurred, and was again removed and examined, and the previous microscopic diagnosis was confirmed. April 25, 1896, the patient appeared after five months' absence; at this time the growth had extended completely over the cornea and covered a portion of the temporal sclera. Microscopic examination of a piece of this showed a decided change in its structure, it being now a typical epithelial carcinoma. Finally, the patient reappeared with a large mass filling the orbital space. This was removed by scissors and there was no recurrence until his death two years afterwards, although microscopic examinations of the tumor showed it, like the former sections, to be a true carcinoma.

Cornea, Catarrhal herpes of the. See **Cornea, Herpes febrilis of the.**

Cornea, Chemical staining of the. This accident is sometimes observed in the eyes of workmen engaged in the manufacture of aniline dyes and naphthaline; long exposure to the emanations from these chemicals produces a deep-gray or smoky-brown opacity of the cornea. The part of the cornea commonly affected corresponds to the area most exposed, i. e., the palpebral fissure. The condition is not attended by inflammatory symptoms, the only pathologic change noted being a roughening of the corneal epithelium.

A change of occupation is followed by a disappearance of the opacification.

Cornea, Choroidal portion of the. The posterior limiting layer and the internal endothelium.

Cornea, Collapse of the. This condition results from marked diminution of the intra-ocular tension, following the escape of the aqueous or vitreous humors, or of both. It is especially prone to occur when, added to the above factors, the lens has been removed and the thickness of the cornea has diminished as a result of old age. In other words, collapse of the cornea depends for its occurrence upon loss of resistance to the external atmospheric pressure. *Partial* collapse of the cornea varies from an uneven appearance from one of wrinkling rhytidosis corneæ) to total collapse (collapsus corneæ), when the loss of aqueous or vitreous has been considerable and the pushing in of the cornea becomes maximum.—(J. D. L.) See, also, page 2323, Vol. IV, of this *Encyclopedia.*

Cornea, Colloid bodies in the. Hyaline degeneration of the cornea. Colloid of the cornea. The last form of degeneration of the corneal tissues is rare. The other form—the so-called hyaline degeneration—is not such an unusual one. G. Lenz (*Klin. Monatsbl. für Augenheilk.*, Oct., 1907) describes a case in a patient who had a wound of the cornea from a foreign body some twelve months before he noticed his visual defect. In the transverse zone of the cornea exposed by the lids there were three intensely white and quite superficial opacities, the surface of which was in part smooth and at parts dull and granular. Around and between the patches there was a cloudiness of the cornea, which reached at one point to the limbus, where superficial vessels entered it. Only one eye was affected, and the upper and lower parts of the affected cornea were normal. The white patches were repeatedly removed, on one occasion freely with Bowman's membrane and some of the corneal lamellæ; but the condition recurred in a very short time. No increase in their size was noticed.

The pathological changes, confined to the epithelium, consisted in swelling and separation of the cells with degenerative changes in the nucleus. Towards the surface the cells elongated into bands, granules showed in the protoplasm, the cells became homogeneous, refractile and stained intensely with eosine; a dense membrane was thus formed.

Lenz believes that band-shaped opacity of the cornea is essentially different from the changes observed in his case. The pathological process is one of degeneration of a hyaline form—the material formed being a colloid. See, also, **Cornea, Hyaline degeneration of the.**

Cornea, Coloboma of the. See **Congenital anomalies of the eye.**

Cornea, Congenital abnormalities of the. Among numerous anomalies of cornea may be mentioned *congenital opacities* and vascularization of the cornea, due to either developmental defects, ocular injuries during parturition or to keratitis *in utero.* The *large cornea* in *congenital glaucoma* (buphthalmos) is brought about by developmental defects of the ligamentum pectinatum and the canal of Schlemm. Congenital anterior staphyloma, opacities and vascularity of the cornea are, according to Treacher Collins, due to "atypical development of the mesoblast intruding between the surface epithelium and lens vesicle." Congenital opacities and vascularization of the cornea frequently co-exist. It is notable that congenital opacities are not attended by any excavation or facet. *Congenital corneal opacities* (see **Cornea, Congenital opacity of the**) are usually present in microphthalmos and congenital anterior staphyloma. Viewed in microscopical sections, the cornea shows absence

of the anterior limiting membrane, departures from the normal of the fibrous tissue lamellæ of the parenchyma and the presence of deep blood vessels. We occasionally meet with congenital opacities which are more or less colored. See, also, **Cornea, Melanosis of the.**

Sclerophthalmos is a congenital corneal abnormality in which the corneal margin is obscured by a dense white opacity characterized by its similarity to that of the sclera, occupying a part or a whole of the circumference of the cornea. Arcus juvenilis (*embryotoxon*) is another congenital marginal opacity which has the form of a complete ring free from vascularity and differing from arcus senilis (*gerontoxon*) in that there is no diaphanous zone interposed between the opacity and the margin of the cornea. Corneal opacities are frequently associated with other anatomical configurations of the cornea.

Congenital ectasiæ have been reported by Pincus, Würdemann, and others. Pincus ascribes his case to an inflammatory condition active in the second half of fetal life. In Würdemann's case, the protrusion was 5 mm. high and 7 mm. in width, with no disturbance of transparency, a feature which makes the case unique.

Microcornea is always present in cases of microphthalmos. Fuchs has observed that in many cases of inherited lues, the cornea assumes the form of a vertical ellipse.

Congenital ectasia is probably due to a delayed development in the fetal cleft forming a *coloboma* of the cornea, which later becomes filled with corneal tissue, varying greatly from the normal, which is formed during the later weeks of intra-uterine life.

Congenital staphyloma is described elsewhere. See, also, **Congenital anomalies of the eye.**—(J. D. L.)

Cornea, Congenital opacity of the. This rare anomaly is probably the result, in most instances, of intra-uterine infection or inflammation. Mohr found opacities in eight out of 60,000 cases of eye disease studied by him. In five examined microscopically there was evidence of inflammation both in the cornea and iris, and in one case in the ciliary body. In some of the cases lesions of the anterior capsule of the lens, posterior polar opacity and anterior lenticonus were found. Two of the eyes had been glaucomatous. Seefelder reports three cases of congenital opacities which also seemed clearly due to severe inflammation during intra-uterine life. In two there were vascular corneal scars and in the third complete loss of the cornea.

A form of congenital opacity of the cornea, non-inflammatory, without other defect of the eye, gray or bluish in color, and giving much the appearance of ordinary parenchymatous keratitis, has been observed by Armaignac. (*Soc. Fr. d'Opht.*, 1911.) The infant

was seen when three months old; the opacity then occupied the whole cornea, except a transparent strip 2 mm. wide at the periphery. Six months later the cornea had become transparent, except a patch 3 mm. in diameter at the center. This child was healthy and of healthy family. But a child born of the same parents four years previously, presenting the same appearances of the cornea, had died at the age of six weeks. See **Congenital anomalies of the eye**; especially page 2804, Vol. IV of this *Encyclopedia*.

Cornea, Congenital staphyloma of the. CONGENITAL KERATOCELE. There are two hypotheses to account for this condition: intra-uterine perforating ulcer, and malformation or imperfect differentiation. The former theory is supported by certain structural changes which strongly indicate its correctness and render the latter less plausible.

Coats gives the following observed structural changes as reasons which support the intra-uterine perforating ulcer hypothesis which assumes that the infection, probably microbic, reaches the cornea through the liquor amnii:—marked destruction of the superficial corneal layers; close fusion of tissue near the corneal center, with complete marginal differentiation; advanced development of the capsule; absence of the lens which has escaped from the eye (at least it is absent) and the relative dragging forward of the uvea or more external structures.

Reis observed a congenital defect of Descemet's membrane in an infant and describes the conditions, which he studied in this case, as, clinically, a fine parenchymatous opacity of the cornea which obscured the iris and pupil; anatomically, absence of Descemet's membrane and the endothelial layer, and a circular anterior synechia.

Stevenson has described a case of bilateral congenital anterior staphyloma occurring in a two-months-old infant (born at full term) that lived two months and several days. Other congenital anomalies were present in the child. The ocular appearances during life suggested maldevelopment rather than inflammation, which impression was confirmed by the microscope. The failure of development was confined to the mesoblast. The staphylomatous cornea varied much in form over the underlying lens and no anterior chamber was present. Monesi reports a similar condition of the cornea in the eye of a youth of seventeen. The eye was removed on account of secondary glaucoma and displayed marked characteristics of congenital malformation. Monesi believes his case originated late in fetal life, with syphilis as the cause.

Treacher Collins, referring to the pathogenesis of this disease, says: "It presents both clinically and pathologically appearances very

similar to those of anterior staphyloma which occurs in infancy as the result of a perforating ulcer.

"There is a variable amount of corneal opacity and often vascularity. The iris is in contact, or adherent, to the posterior surface of the cornea so that there is no anterior chamber and no means of escape of the aqueous humor from the eye, the increase of intra-ocular tension thereby occasioned causing the expansion of the anterior part of the globe.

"Several observers have been led to infer that the change in these cases must have resulted from intra-uterine ulceration. It is, however, very difficult to believe that a perforating ulcer of the cornea could occur *in utero,* heal, and result in a fully developed anterior staphyloma before birth. In one recorded case of congenital anterior staphyloma the whole of Descemet's membrane and the ligamentum pectinatum were found absent. The complete absence of these structures never results from ulceration of the cornea.

"It would seem in the cases which have been examined pathologically that the mesoblast which grows in between the surface epithelium and the lens over the whole or a portion of its extent, failed to become in any way differentiated. Over the affected area the anterior fibro-vascular sheath and Descemet's membrane were not formed, the mesoblast being there entirely converted into a vascularized mass of fibrous tissue. The two layers of the secondary optic vesicle which form the pigment epithelium of the iris had spread beneath it, but as there was no anterior fibro-vascular sheath no stroma of the iris developed. The blood vessels which should have supplied it passed instead into the mass of undifferentiated fibrous tissue."

Pincus believes the affection to be due to inflammation occurring in the second half of fetal life.—(J. D. L.)

Peters (*Klin. Monatsbl. f. Augenheilk.,* Sept., 1908) holds that congenital staphyloma is due to defective development of Descemet's membrane. He adds another case to those he has already published in support of this view. He finds a defect in Descemet's membrane surrounded by an incomplete synechia. The anterior chamber was obliterated and the iris and lens were pushed forward against the cornea. There were signs of arrested development in each eye, particularly embryotoxon. The following facts, drawn from this and other cases investigated, are in favor of Peters' view: The absence of inflammatory signs, the hereditary tendency to the disease, the bilateral symmetry of the defect, the absence of disease elsewhere in the bodies of mother or child, and the presence of other malformations not of inflammatory origin, as congenital corneal opacity, micro-

phthalmos, irideremia, buphthalmos, megalocornea and embryotoxon. He suggests that there may be defective separation of the lens from the ectoderm, or defective implantation of the portion of tissue destined to form the corneal crown, or it may be due to pressure of the amnion. Bietti, in the anatomical examination of a diseased eye, discovered an internal ulcer associated with parenchymatous keratitis, probably of tubercular origin and secondary to iridocyclitis. According to von Hippel (Graefe's *Archiv f. Ophth.,* Vol. 68, No. 2, 1908), such parenchymatous inflammations follow loss of the endothelium and penetration of the aqueous instead of the ulcer resulting from an extension of the corneal disease.

Cornea conica. (L.) Conical cornea.

Cornea, Conical. Keratoconus. Cornea conica. Hyperkeratosis. This subject will be found fully discussed on page 2976, Vol. IV, of this *Encyclopedia.*

Cornea, Conjunctiva of the. See page 3013, Vol. IV of this *Encyclopedia.*

Cornea consumta. (L.) Atrophy of the cornea.

Cornea, Corpuscles of the. A variety of connective-tissue corpuscles found in the fibrous groundwork of the cornea. They contain an oval nucleus and are provided with numerous branching processes which anastomose freely with those of the corpuscles of the same and adjacent planes.

Cornea, Crescentic ulcer of the. This term was suggested by the appearance of the lesion and was applied by many of the early ophthalmologists, Soelberg Wells, for instance, to a form of serpent ulcer of the cornea. It has also been given to *ring ulcer* of the cornea (q. v.). It is this form of corneal ulcer described, in a series of six cases exhibiting certain distinctive clinical characters, by Dunn (*Arch. of Ophth.,* Vol. 39, p. 120, 1910), but without bacteriologic observations. All the ulcers were in adults of from 27 to 58 years of age, five in men. The ulceration began as minute areas of infection beneath Bowman's membrane, near the corneal periphery. It spread peripherally and centrally to occupy one-third or two-fifths of the corneal surface. There was little conjunctival irritation, and no marked secretion. Descemet's membrane escaped for a long time; and in only one case was there hypopion. The ulceration was resistant to all forms of treatment until hydrogen peroxid was used. This was applied after the surface was rubbed firmly with cotton wrapped closely around a fine probe. At the first application the peroxid penetrated the cornea, causing a whitish area of minute bubbles considerably larger than the original loss of substance. But the subsequent applications, which were made once or twice daily, produced no such pene-

tration. Apparently the infection had been overcome and the process limited by the first treatment. A somewhat similar ulcer followed by apparent ectasia is reported by Charles (*Amer. Jour. Ophth.*, Vol. 27, p. 136, 1910). Bietti (*Arch. d'Opht.*, Vol. 30, p. 653, 1910) reports a case in which the ulceration was caused by a bacillus corresponding exactly to that described by zur Nedden as the cause of marginal ulcer.

Cornea, Crystalline opacities of the. Grimsdale (*Oph. Review*, April, 1911) reports a case in a woman, æt. 67, in which the central area of each cornea showed opacities, on different levels, which had the appearance of frost crystals. There was no raising of the epithelium. A similar condition was present in the cornea of a cousin.—(J. D. L.)

Cornea, Curvature of the. See **Anatomy of the eye.**

Cornea, Cutaneous portion of the. CONJUNCTIVAL CORNEA. External epithelium of the cornea.

Cornea, Cysts of the. See **Cysts, Corneal.**

Cornea, Decentration of the. Of two causes for compensating vertical and lateral heterotropia, one is a decentration of the cornea; the other is displacement of the macula. It would probably be more nearly correct to say that there is but one other cause—that is, decentration of the cornea. The antero-posterior axis of the eye, that axis controlled by the recti muscles, which must always be at right angles to the equator of the eye, can be none other than the visual axis. Commencing always at the fovea centralis, it passes always through the center of retinal curvature and thence through the center of an ideally placed cornea; but if the cornea is not properly centered, the visual axis passes through some other part than the center. The posterior pole of the eye, whether near to or far away from the optic disc, or above or below it, is the center of the macula; the anterior pole may or may not be the center of the cornea. In ideal eyes—eyes that see best or can be made to see best —the anterior pole is the center of the cornea. The antero-posterior axis of the eye, as given by anatomists and adopted by writers of books on the eye, has its beginning at the center of the cornea, passes backward through the center of rotation, and strikes the retina, maybe at the macula, but is just as likely to strike it elsewhere. The error is in giving the anterior pole a fixed location—the center of the cornea. Such an axis can be at right angles to the equator of the eye in which lie the vertical and transverse axes of the eye, only when it coincides with the visual axis. It can be of value only in determining the extent of the decentration of the cornea, or how much the cornea lacks of occupying the ideal position.—(G. C. S.)

Cornea, Deep ulcer of the. This name is often applied to those corneal ulcers that, clinically, occupy a position between simple ulcer and the more malignant forms of serpent ulcer. It is, however, of the suppurative variety and like serpiginous ulcer is prone to involve the deeper layers of the cornea even to perforation of the latter. It follows, as a rule, injury to the cornea attended by infection from some pyogenic germ accidentally present in the sac; or infection may occur during a purulent inflammation of the conjunctiva due to the presence of the gonococcus, pneumococcus or other pus microbe.

This serious disease is usually accompanied by severe pain in the eye and the frontal region, photophobia, lachrymation and congestion of the iris and ciliary body. Pus, fibrin with leucocytes and some pyogenic microbes frequently form in the anterior chamber (hypopyon) changing their locality according to the position in which the head is held. When the patient holds the head upright the hypopyon is at the bottom of the anterior chamber and appears there as a grayish-white streak, or it may extend to the margin of the pupil. If the patient lies down the pus gravitates to the outer portion of the anterior chamber.

The amount of purulent liquid varies; sometimes it almost fills the anterior chamber, while at other times the amount is so small that it can only be detected on closest examination. The quantity of pus in no way depends upon the extent and severity of the ulcer. This so-called pus is often really sterile since it is not, as a rule, derived from the ulcer itself. The membrane of Descemet forms a barrier that does not allow any foreign material to penetrate into the anterior chamber. The hypopyon is mostly made up of leucocytes derived from the iris, which wander from the bloodvessels of that structure and accumulate in the anterior chamber; sometimes the liquid of the hypopyon is very thick, at other times it is quite watery.

Deep ulcer is usually round and varies in size. Its floor is covered with pus; its edges are frequently swollen and surrounded by a grayish infiltration. It has no tendency to spread, but its chief disposition is to open into the anterior chamber. When perforation is about to occur actual bulging of Descemet's membrane into the cavity of the ulcer may be observed on close inspection.

When perforation takes place the aqueous humor gushes out; the iris is pushed forward and either becomes entangled in the corneal opening, or (especially if the perforation be peripheral) suffers prolapse.

If the ulcer is situated in the center of the cornea (pupillary area) out of reach of the iris, the anterior capsule of the lens becomes

applied to the perforation wound. In either case plastic material is thrown out which glues the iris to the margins of the corneal opening, preventing the escape of more aqueous and allowing the anterior chamber to reform. The iris thus becomes incarcerated in the wound and an anterior synechia forms. The ulcer heals and in time a dense white cicatrix (leucoma adherens) is the result.

If a decided prolapse of the iris has taken place, we are likely to have bulging of the affected cornea (anterior staphyloma) of greater or less extent, due to the action of the intraocular pressure on its weakened walls.

Fortunately, perforation does not occur in all cases of deep ulcer because the deeper layers of the cornea, and particularly the membrane of Descemet, are tougher than the superficial layers and are better able to resist the destructive process that is going on. When it does occur its results are often disastrous, not only on account of the marked interference with vision but, also, as a result of the entrance of pyogenic micro-organisms into the interior of the eyeball. The suppuration then extends to the internal structures and total destruction of the globe from panophthalmitis may follow.

Treatment is that of serpent ulcer of the cornea (q. v.).

Cornea, Dendritic ulcer of the. MYCOTIC KERATITIS. FURROW-KERATITIS. This superficial form of corneal infection is characterized by small, branching, furrow-like ulcers that do not penetrate deeper than Bowman's layer. Although all cases are not of malarial origin the plasmodium can often be found in the majority. As Posey (*Annals of Ophthalm.*, April, 1913) points out, this form of ulcer is associated with various types of superficial keratitis. He refers to the infrequency of dendriform ulcer in women. Has had recently under his care a number of young men with dendriform opacities, in whom a persistent conjunctivitis apparently played an important part. In the treatment he believes that at first all irritation should be avoided, cauterization of the cornea being resorted to only when the opacity showed a tendency to spread and to resist milder measures. He prefers carbolic acid to other drugs, care being taken to limit the application of the crude acid to the part affected.

Subsequent applications of an ointment containing atropin, iodoform and vaselin relieved pain and promoted healing. He has found holocain of little value in the treatment of this affection.

Zentmayer says there is a wider acceptance of the view that dendritic ulcer, herpes cornealis, superficial punctate keratitis and allied superficial forms of keratitis are of neuropathic origin than formerly, but he does not consider the evidence sufficient to include all within

this etiology. As to the treatment, his attention was called to the value of holocain in these conditions some years ago by de Schweinitz's memorandum of the value of this drug in relapsing erosions of the cornea, and he has since used it in all corneal conditions and he thinks with decided advantage, combining a compress bandage in some forms. Finding that oil of turpentine, next to the solid stick of nitrate of silver, was the most efficient treatment for aphthous stomatitis, he was led to use it in corneal ulcers, and it seems to be of special value in dendriform ulcers. He recalled that in a very pronounced case of filamentous keratitis which had resisted all forms of treatment, he had, at the suggestion of Posey, employed a strong yellow oxid ointment with benefit.

Verderame (*Ann. di Ott.*, Vol. 41, p. 223, 1911) reports a case seen the day after the cornea was injured by a particle of stone. The infiltrated area was the size of a pin-head, and showed alternating rings of hazy and clear cornea. The ulcer still had the level of the surrounding cornea, and was not marked off by the usual sulcus. Healing was complete in eleven days. Experiments with rabbits showed that the spore-bearing organs of the *Aspergillus fumigatus* in the scrapings of the ulcer rendered possible the diagnosis by the fifth day. In Heilbrun's case (*Klin. Monatsbl. f. Augenheilk.*, Oct., 1911, p. 444; *Ophthalmoscope,* Vol. 10, p. 185, 1911) there was no known injury, but three days after the appearance of pain an infiltrated disk 7 or 8 mm. in diameter was present. The infiltration was more dense toward the periphery, the area anesthetic, and the other parts of the cornea steamy, although sensitive. Cultures showed *Aspergillus fumigatus.* Marx (*Klin. Monatsbl. f. Augenheilk.*, Mar., 1911, p. 361) reports two cases. In both, as in Heilbrun's case, there was hypopyon; and at first, as in Heilbrun's case, no groove marked off the lesion. The cause was not suspected until cultures had been made from the corneal scrapings.

Cornea, Depressions in the. Fuchs (v. Graefe's *Archiv fur Ophthal.* 78, 1, 1911) discusses certain small flat depressions at the edge of the cornea, usually found on the temporal side and partly extending into the limbus. The depression is commonly vertically oval, measuring 1—2 mm. by 2·5—3·5 mm. The edge towards the limbus is gently sloping, that towards the cornea steep. The depth is barely half a millimetre, the floor slightly opaque and rough and the deepest part dry and xerotic. The sensibility of the affected area is reduced and there may be slight injection of the adjoining conjunctival and ciliary vessels. The lesion only exists for a few hours up to two days at the most and causes no symptoms except an insignificant burning

sensation. The author has noticed these depressions in cases of swelling of the soft parts at the limbus either inflammatory or otherwise, after the use of cocaine in two cases, twice after cataract operation, once in hemeralopia, once in lagophthalmos and in three cases without assignable cause. A microscopical examination was made in one case. The epithelium was thinner over the depression on account of shrinkage of the cells and the subepithelial tissue was similarly affected. Fuchs believes the condition to be due to temporary local loss of fluid, possibly owing to a lesion of some of the superficial nerve twigs passing into the margin of the cornea. It is of physiological rather than clinical interest.

Cornea, Dermoid growths of the. Only a few cases of dermoid tumors, *limited to the cornea,* have been reported; they were, of course, congenital. Fuchs describes a case in a boy of twelve, in which the dermoid occupied the outer half of the cornea from the center to the limbus. The growth consisted of an outer covering of corneal epithelium (not epidermal) and the growth proper consisted chiefly of connective tissue, interspersed with dilated lymphatics. No hairs or sebaceous glands were present, but one which resembled a Krause gland was found.

Bernheimer saw a case in an infant six months old. There was an anterior staphyloma covered with horny epithelium showing many down-growths. The tumor contained numerous hairs, hair follicles and sebaceous glands.

O. Napp (*Practical Medicine Series,* p. 173, 1911) reports a large corneal dermoid which he saw in a new-born child. Napp's histologic description of his case is as follows: It was composed of loose connective tissue with elastic fibres; lymphatic spaces lined with endothelium; small cartilage (not hyalin) plates, between which were lobes having some of the characteristics of sudoriferous glands and of fat tissue. The tumor contained numerous blood vessels; the epithelium and subepithelial layers showed numerous round cells.—(J. D. L.) See, also, **Dermoids, Ocular.**

Cornea, Development of the. EMBRYOLOGY OF THE CORNEA. The cornea develops upon an embryological truss-work, known as the anterior vitreous, which is of ectodermal origin. The Descemetian endothelium arises as a differential product of this truss-work and from it there springs the basal membrane that later develops into Descemet's membrane proper. From the ingrowing mesoderm, there gradually develops the tissue that by mitotic division forms the ground-substance of the cornea, and scattered throughout this are the elastic fibres whose origin is still an open question. Bowman's membrane is also a sub-

product of the ground-substance and is first seen as a very fine fibrillar meshwork which later becomes homogenous. The corneal epithelium is merely a continuation of the ectoderm over the surface of the entire embryo.

From a study of the developing eyes of birds, dog-fish, frogs and rabbits, von Knape (*Ophthalmoscope,* Vol. 8, p. 588, 1911) concludes that the anterior vitreous and the corneal plate arise together; while the posterior vitreous develops from the lens and the retinal layer. Both Bowman's membrane and Descemet's membrane develop from the anterior vitreous; and afterward diapedesis of mesenchyma cells occurring between them furnishes the beginning of the parenchyma of the cornea. See, also, **Development of the human eye.**

Cornea, Diplobacillary ulcer of the. DIPLOBACILLUS ULCER. Ulcer of the cornea due to infection from the Petit, Morax-Axenfeld or similar diplobacillus, exhibits certain characteristics that distinguish it from other forms of corneal ulceration. The diplobacillus ulcer is generally of a circular form and is covered with a vitreous, gray deposit. The border has a glassy, mucous appearance; under the loupe it appears puffy. The depth of penetration depends upon virulence; deep, streaked, and radiating forms occur. The hypopyon is often less yellow, but in most other respects two ulcers may present the same clinical picture. By a careful following of the zinc therapy every case can be cured. Generally the ulcer will heal while the edge is advancing. Only delicate maculæ result. These special characters are discussed in the body of this caption.

Löwenstein (*Klin. Monatsbl. f. Augenheilk.,* Vol. 51, p. 286, 1913) gives a histological report of two cases of diplobacillary ulcer of the cornea, in which these alterations are emphasized and illustrated. See the plates.

Martin Zade (*Klin. Monatsbl. f. Augenheilk.,* August, 1908) records the appearance and progress of twenty-five cases of corneal ulcer in which the Morax-Axenfeld bacillus was obviously the infecting agent. The Petit type occurred in three of the twenty-five. The ulcers were of the single, centrally situated type, which occurs in cases where there is no evidence of an angular conjunctivitis. In regard to the very important question of the differential diagnosis of these ulcers from the pneumococcal variety Zade says that "When a diplobacillary ulcer is watched throughout its whole course it will be found to have quite distinct characteristics;" he considers that a typical appearance cannot, however, be described. The features, which are most regular, are a circular, disc-like outline, and a base covered with slimy, grey débris. The margin may resemble that of the pneumococcal ulcer,

A. Pathological Changes in the Cornea from Diplobacillary Ulcer of the Cornea.

(A. Löwenstein.)

B. Histological Changes in the Cornea the Result of Diplobacillary Ulcer of the Cornea. (A. Löwenstein.)

but the infiltration is neither so opaque nor so deep. The infiltration in the cornea itself may be in the form of radial or concentric lines. The hypopyon is not so yellow in color. The spread is by an advancing margin which is not so deep as that of a pneumococcal ulcer. Regarding *treatment,* Zade fully agrees with previous observers as to the almost specific action of sulphate of zinc. "The best results are obtained by early treatment with zinc." The Freiburg treatment is recommended: compresses of 3 to 1,000 zinc sulphate solution applied for several hours at a time, drops of ½ per cent. zinc sulphate instilled every half hour, and between times, as at meals, and for the night, an ointment containing 1.5 per cent. ichthyol and ¼ per cent. zinc sulphate was introduced into the conjunctival sac. The cases show that this treatment gives equally good results as regards the ulcerative process and leaves a slighter scar than the cautery.

The whole article is a striking testimony to the value and necessity of a bacteriological examination in all cases of corneal ulcers which resemble the so-called ulcus serpens type. (A. Macnab, *Oph. Review,* Nov., 1908.)

The importance of a precise bacterial diagnosis is attested by Gallemaerts (*Am. Jour. Ophth.,* Jan., 1908). When the Morax-Axenfeld diplobacillus is found the zinc sulphate treatment never fails (in his experience) to cure. The ulcer is cauterized with a 40 per cent. solution, and a 1 per cent. solution used as a collyrium three times a day. The hypopyon disappears in from 24 to 36 hours. Gallemaerts was not obliged to resort to the cautery or paracentesis, and the resulting scars were small and faint.

Peters has had some failures with the zinc treatment in diplobacillus ulcer, and has substituted in its place boric acid and dionin. For these obstinate cases Allen (*Practitioner,* May, 1908) recommends the use of a diplobacillus vaccine. Zur Nedden (*Zeitschr. f. Augenheilk.,* Oct., 1908, p. 380) believes that the chief aim in the therapy of all infective eye diseases should be to increase the strength of the patient, and to make the greatest possible use of the natural healing factors of the body. Treatment should not aim to kill the bacteria directly, but to influence the body to transfer to the point of attack the natural bacteriolytic elements. The remedies which act in accordance with this principle are the astringents, iodoform, paracentesis, subconjunctival injections, heat, ray treatment, all of which set up hyperemia of the uvea, and cause an increase of the bacteriolysins.

Vasek (*Zeitschr. f. Augenheilk.,* Dec., 1908) cauterizes every case as soon as it appears. He finds that the resulting opacity is no greater than would otherwise have occurred. Out of 58 cases, 51 were cured

by one application. In four it was repeated. In nine cases in which perforation occurred, the ulcer had already involved two-thirds of the cornea before the case was seen. As perforation may occur at any time, from one day to three weeks after cauterization, the patient must be kept in bed. The cautery should not be drawn across the ulcer, but just behind the advancing border; a series of punctate eschars should be made, by touching the area with a blunt point heated to a red glow. When a gray-yellow streak penetrates all layers the cauterization must be done very thoroughly. Paracentesis was necessary in only one case. This operation is not indicated if the hypopyon is thick and small in amount. The average duration of the treatment was nineteen days. Only fourteen per cent. of the eyes were lost. Todd (*Ophth. Rec.*, April, 1908) praises the Wordsworth cautery, which consists of a copper bulb and a platinum point. When these are heated to redness they remain hot enough to cauterize for several minutes.

The cautery, while it kills the microörganism, also destroys the corneal cell. Wirtz (*Klin. Monatsbl. f. Augenheilk.*, Nov.-Dec., 1908) believes that the corneal cell can usually withstand more chemical irritation than can most of the microörganisms which attack it. He was also able to grade the dosage of zinc introduced by iontophoresis so nicely that it killed the microbe without injuring the corneal tissue. A current of two milliamperes was used for two minutes. Six cases were so treated, in three of which the pneumococcus was present, and in the others diplobacilli, twice of the Petit type. He brought the process to a standstill in each case. In four, only one application was necessary to render the diplococcus or the pneumococcus innocuous. The pain ceased in a few hours; after twenty-four hours improvement was noted, and after five or six days the ulcer showed a reflecting surface. The opacity left was never greater than the original size of the ulcer.

Weekers (*Ann. d'Ocul.*, Vol. 142, p. 15, 1909) examined microscopically a diplobacillus ulcer which occupied the lower half of the cornea. The surface of the ulcer was formed by necrosed polynuclear leucocytes which rested upon thin and altered corneal tissue. The epithelium was absent over the ulcer. Near the ulcer the membrane of Bowman was bare, and further away the basal cells of the intact epithelium were infiltrated with leucocytes, some of which could be seen making their way through Bowman's membrane. The corneal tissue was infiltrated, not uniformly, but rather in two zones, one superficial beneath the base of the ulcer, the other deeper, bordering the anterior chamber. The two were separated by a zone of less

infiltration. The membrane of Descemet was absent over a large part of the ulcer. Petit holds that early perforation of the membrane have been in glaucomatous eyes. No glaucomatous signs were observed in this case. The iris was infiltrated and there were masses of pigment irregularly distributed through its stroma. Similar findings were recorded by Nuel in a case with hypopyon. The diplobacillus was best seen when the blue polychrome staining of Unna was employed. The bacilli were most numerous in the edge of the ulcer between the epithelium.

Oreste (*Ann. d'Ocul.*, Vol. 142, p. 266, 1909) discusses the subject of ulcers caused by the bacillus of Petit. He describes the ulcer due to this organism as preferring the center of the cornea, having generally a rounded form and a grayish base. Its borders are a little undermined and it tends to extend superficially. Hypopyon is generally present, together with a moderate iritis. There is generally more or less conjunctival chemosis. Pain and photophobia are not intense and fever and general reaction are absent. He has always found it to be monocular, to occur only in adults and usually accompanied by dacryocystitis. Its duration is from one to six weeks. The cornea he considers to be primarily affected, as he has never seen a case with conjunctivitis. In this it differs from ulcerations in which the Morax-Axenfeld diplobacillus predominates, which are generally seen accompanying or following an attack of subacute conjunctivitis. Moreover, the latter are usually situated near the limbus, are rarely complicated with iritis or hypopyon, and get well under zinc therapy. On the other hand, the ravages of the Petit bacillus are not controlled by local medication, but often require surgical measures. Oreste instilled the Petit bacillus from two different sources into the healthy conjunctival sac with negative results. Paul regarded the Petit and the Morax-Axenfeld bacilli as identical, and Axenfeld and McNab have shown that the former loses after a time its property of liquefying gelatin; no one, however, has been able to grow the latter upon serum-free media.

The author sums up the distinguishing characteristics of the two forms as follows: The Petit bacillus is smaller—and its ends are more rounded. It grows readily upon media not containing serum and has the property of liquefying gelatin. Its colonies are more salient and less transparent. It develops at the ordinary room-temperature, while the Morax-Axenfeld requires a temperature of from 30 to 38 degrees. In the author's experience, the Petit bacillus occurs in 20 per cent. of the cases of ulcus serpens. Clinically these cases differ from those

caused by the pneumococcus in that the pain is not so severe and the iritis is not plastic.

Rosenhauch (*Klin. Monatsbl. f. Augenheilk.*, Sept., 1908, p. 257) saw ten cases of ulceration due to the bacillus of Petit, four in men, six in women, all about fifty years of age and all accompanied by iritis and hypopyon. Most of them appeared of a glassy-gray color, rarely they were yellow. The ulcers were large and as in Oreste's cases occupied the center of the cornea. In five of the cases there was history of trauma; two only had dacryocystitis, and in these the bacillus was not present in the discharge. Two of the cases resembled ulcus serpens and showed an advancing border, but the other border showed no signs of cicatrization. The infiltration was deep, four cases penetrating to Descemet's membrane. One case was surrounded by a ring of foci like a string of pearls. They were elevated above the surface and contained pure cultures of the bacillus. According to this writer, in the cases hitherto reported, iritis has not always been present. Some of the cases got well when treated with pyoktanin, and three by the use of electralgol.

Cultures of the Petit bacillus upon agar form compact, rounded, slightly projecting, finely granular, gray colonies with smooth borders. A brownish pigmentation appears in some cases. Upon gelatin they begin to grow at the upper end, gradually sinking deeper to form a funnel; the organism is pathogenic for the rabbit and the guinea pig. (*Ophthalmic Year-Book*, 1909-1910.)

Cornea, Discoloration of the. See **Cornea, Melanosis of the.**

Cornea, Dystrophy of the. Dystrophies are affections of the cornea which, not classed as suppurative or non-suppurative, form an intermediate progressive group to which Fuchs has given the foregoing name. They are anatomically characterized by non-inflammatory, degenerative changes in the cornea resulting from disturbances of nutrition, which are either local, general, or both. Dystrophies of the cornea are chronic progressive affections (usually bilateral), which appear in persons of advanced age, or in those who suffer from chronic malnutrition. Females are more frequently afflicted than males. These corneal disturbances are essentially retrograde metamorphoses, and the processes are free from leucocyte invasion.

Dystrophia epithelialis corneæ. In this disease, which Fuchs has seen in about one in 2,000 patients, an opacity appears at the center of the cornea and, as the process continues, it becomes more intense as it increases in area, gradually fading away as it approaches the periphery of the cornea, leaving an annular area unmolested. Microscopical examination of the cornea shows the disease to be limited

to the epithelium and the most anterior layers of the corneal stroma. The epithelial layer becomes swollen, thickened and insensitive and, in advanced cases, transparent vesicular elevations appear in this membrane—sometimes as a raised line in the horizontal meridian.

Dystrophia epithelialis corneæ is quite similar, in its clinical picture, to glaucoma. But, aside from the nephloid appearance of the cornea, there are no other symptoms common to glaucoma, nor does the appearance of this disease (glaucoma) seem to be influenced by this form of dystrophy. However, some investigators believe that there may possibly be some connection, but the relation, if any, has not been demonstrated. Aside from the fact that there are clinical appearances suggestive of both diseases and that *chronic* glaucoma, in its advanced stages, has been noted as a secondary complication, a relation is not evident.

Reese names three forms resulting from malnutrition: (1) Those due to deposits of mucin and occurring in myxedematous subjects; (2) those following thyroidectomy, and (3) the grayish-green discoloration of the cornea occurring in disseminate sclerosis.

Leber and Fuchs, in their pathological studies of this disease, observed new-formed tissue between the epithelium and Bowman's membrane, which Fuchs states consists of homogeneous connective tissue without any signs of hyaline or hornification. In the early stages the epithelium is probably thickened and occasionally vacuolated, especially in advanced cases. The large vesicles result from a separation of the epithelium and Bowman's membrane, induced by vacuolation. A characteristic feature of the opacity in dystrophia epithelialis corneæ is the tendency to extend downward.

P. Knapp examined a case microscopically and, from the vacuolation of the epithelium, associated with an abnormally soft condition of the parenchyma, advocates the theory of edema.

Anesthesia of the cornea, which is rarely absent, is due to injury to the nerve fibres of the epithelial layer, or probably those which pass through Bowman's membrane. The fact that corneal anesthesia precedes the epithelial changes, may have an important bearing upon the pathogenesis. It has not been determined, in any of the cases reported, that occupation is accountable for the development of this disease.

The symptoms of irritation are not constant and, when present, are slight. Recrudescence of pain has been noted in a number of cases reported. There has not, as yet, been any effective *treatment* suggested for this disease.

Arcus senilis (gerontoxon) is, as its name implies, a condition observed in elderly people, yet instances of its occurrence earlier in

life, in some families, have been frequently observed. It begins at the periphery of the corner—usually above—in the form of a crescentic opacity; later, a similar condition appears below. These slowly increase until they meet and form a complete ring. Between the arciform opacification of the cornea and the sclera, except in rare instances, there is a diaphanous zone. Canton states that he has never seen Bowman's membrane otherwise than unaltered, a finding which seems to be general among investigators of this disease. Arcus senilis is a physiological condition resulting from atypical fatty, degenerative changes. The fatty granules, according to Fuchs and Takayasu, belong to the groups, palmatin and stearin. The opacity is confined to Bowman's membrane, the fibrous lamellæ and corneal corpuscles. Tweedy says: "According to some investigations made by the writer in conjunction with Mr. E. T. Collins, in the laboratory of Moorfields Eye Hospital, the change in the cornea consists in the presence of fine, highly refractive molecules, distributed along the course of the lymphatic spaces and channels of the superficial layers of the periphery of the cornea near the loop-endings of the capillaries of the conjunctival and episcleral blood-vessels. The greater portion of these molecules are not fatty, as is generally supposed; for, unlike fat, they are neither blackened by osmic acid nor dissolved by ether. They probably arise from mucoid degeneration of the protoplasm within the lymphatic channels and spaces of the cornea, and to some extent of the fibrillæ themselves. A few doubtful, blackened, fatty molecules may be seen here and there in sections stained by osmic acid. The fibrillæ are slightly wrinkled, and are more loosely held together than natural, and the spaces between the laminæ are wider. In support of the non-fatty nature of arcus senilis, it may be stated that wounds of the cornea, whether through the opacity, or to its inner side, or to its outer, and whether surgical or traumatic, heal in a natural way."

The conclusions of Marie and Laroche, from their studies of the structure and pathogenesis of arcus senilis, are as follows: The arc is composed of lipoid substances studded with minute points consisting of ethers and cholesterin. They regard the presence of lipoids as evidence of great disturbance of cellular nutrition. They also observed the presence of arcus senilis in persons whose radial arteries were soft and the converse when "pipe-stem" radials were noted.

Zonular opacity of the cornea, also known as ribbon-shaped opacity of the cornea, belongs to the pathological types of dystrophies, a brief account of which may be given here. The opacification is very slow in development. It usually makes its appearance, in elderly people, secondary to some intraocular disease, as glaucoma or irido-cyclitis.

Its appearance is marked by the development of two foci at the outer and inner corneal margins, which opacities are not contiguous with the sclera, but separated from it by a narrow unmolested area. These two original infiltrated points very slowly approach each other, traversing the cornea a few mm. below its centre, corresponding to that part of the cornea most exposed by the palpebral fissure. After many years of progress, the original foci unite, forming a grayish band of opacification about four mm. in diameter. The extremities are somewhat broader and more dense than the band which ultimately connects them. Upon close examination with the loupe and lateral illumination, the margins of the opacity are seen to terminate quite abruptly in the clear portion of the cornea by well-defined margins; also, that there are numerous superficial grayish dots and many small elevations affecting the roughened, superficial epithelial layer. Occasionally, in the midst of the invaded portion, moderately clear, irregular areas are discernible. The anatomical changes, characterizing this disease, depend upon the deposition of minute granules of lime salts in Bowman's membrane and the anterior corneal lamellæ. In addition to the calcification, new-formed connective tissue develops in the opacity. The combination of these two factors produce, as they develop, chink-like breaks in Bowman's membrane.

Lowered resisting powers of the cornea, resulting from disturbance of nutrition, are usually responsible for the development of this disease; however, it does occur secondary to irido-cyclitis and glaucoma without malnutrition being present. From the nature of the deposits found in the cornea in zonular opacities, gout is unquestionably a predisposing cause. Some authorities consider this an occupational disease in which small particles find their way into the eyes.

No *treatment* has been recommended for this disease, except by Fuchs, who advises scraping off the epithelium when the opacity is sufficiently superficial to permit of such a procedure without impairing any of the clear corneal portion corresponding to the pupillary area.—(J. D. L.)

Cornea, Ectasia of the. Under this heading are classified the several conditions which are characterized by varying degrees of protrusion of the cornea and the presence or absence of inflammatory symptoms. Those which are known as keratoconus and keratoglobus are unaccompanied by inflammatory symptoms, while those which have their origin in corneal inflammations are termed *keratectasia* and *staphyloma.*

Keratoconus. Conical cornea. Staphyloma pellucida. In this condition the bulging of the cornea is most pronounced near its center, where the thinning of the cornia propria is greatest—some-

times reduced to one-third of its normal thickness. By applying a probe near the apex of the corneal cone, a distinct dimpling is produced. Keratoconus is a rare disease and, when it occurs, both eyes are usually affected.

This subject is fully discussed elsewhere in this *Encyclopedia*. See page 2976, Vol. IV. See, also, **Cornea, Staphyloma of the.**

Cases of marginal degeneration with thinning and ectasia of the cornea are reported by Van Duyse, Markus, Schutz and Zentmayer. In Van Duyse's case (*Soc. Belge d'Opht.*, No. 29, p. 138, 1911), iridectomy had been done on each eye after the formation of the peripheral groove, which in the right eye had been first noticed twenty-five years before, and in the left five years. In both eyes there subsequently developed ectasia with opacity, with extension of the vessels on to the thin cornea. In the case seen by Markus (*Ophth. Soc., U. K.*, Vol. 31, p. 1, 1911) the anterior chambers were very deep, and each eye presented astigmia against the rule of about 18 D. There was a history of repeated inflammation dating back eighteen years, with gradual loss of vision in the last two years. The general shape of one cornea resembled keratoconus, the other keratoglobus.

The patient seen by Schutz (*Ophth. Rec.*, Vol. 20, p. 214, 1911) was only eighteen years old, but gave a history of repeated attacks of inflammation. His left cornea presented a perforation of the thinned portion and prolapse of the iris at the upper, inner margin. The right showed a crescent in the upper inner quadrant that bulged ½ mm. above the normal surface. Innumerable, fine, branching vessels entered the zone affected, and it was distinctly anesthetic. Both eyes were myopic, but capable of normal vision. The tension measured with the Schiötz tonometer was reduced to 9 mm. Under eserin and a pressure bandage, the marginal ectasia disappeared after ten days, and the prolapsed iris flattened down. In Zentmayer's case (*Sec. on Ophth., Coll. Phys., Phila.*, Oct. 19, 1911) there was marginal degeneration with formation of a groove 2½ mm. broad, ½ mm. deep, involving the upper half of the corneal circumference, which in the right eye was beginning to bulge. Fine vessels encroached upon the cornea, but the eyes were free from inflammation. Junius' patient (*Zeit. f. Augenheilk.*, Vol. 28, p. 42, 1911) was a soldier, aged 29, who had suffered from scurvy and malnutrition. The zone of thin bulging cornea was about 2 mm. wide, opaque and vascular.—(Abstract from the *Oph. Year-Book*, 1912.)

Cornea, Edema of the. This condition, like that of true pressure opacity of the cornea, has its origin in some interference with the circulation of the lymph streams of the corneal tissues. The edematous

process is most pronounced in the anterior layers. The epithelial layers or the anterior layers of the lamellæ are the most pronouncedly involved, yet, microscopically, changes are present in all the corneal layers, even in Bowman's membrane, at a point through which the nerve fibres pass to the epithelium (T. Collins). The condition is characterized by an engorgement and filling with albuminous fluid, in the form of minute droplets, of the anterior lamellæ layers, but greatest between Bowman's membrane and the epithelium. The surface epithelium is rendered quite uniformly dull and uneven by the albuminous accumulations beneath. Edema of the cornea is also found in panophthalmitis and many other ocular affections. In protracted cases, small vesicles may form on the corneal surface. The microscopic changes, according to Parsons' investigations, are as follows: "In the epithelium, small drops of liquid are found at first between the basement cells, but later the channels between the prickle-cells are broadened, and ultimately the edema extends to the superficial cells, which are loosened and often cast off. In hardened specimens the fluid is coagulated in places, forming small granular clots between the cells. The fluid between the basal cells forms small droplets, which may be arranged in rows, like the beads of a rosary. The cells may be lifted up from Bowman's membrane by the fluid. In the middle, layers of the prickle-cells are forced apart, so that the tooth-like processes are very clearly seen, though they do not now interlock as under normal conditions. The superficial cells are usually last and least affected. A few leucocytes are often seen between the cells.

"The cells themselves also become vacuolated. The basal cells are often elongated, the basal parts containing fluid which does not stain, whilst the nuclei occupy the distal ends. If the swelling is great some of the cells burst and leave small depressions, which, together with the swollen and projecting cells, render the surface of the cornea uneven and lustreless. This change is the usual cause of the stippled appearance in cases of glaucoma, iridocyclitis, interstitial keratitis, etc.

"Sometimes the edema affects most the middle or deepest layer of cells, or the epithelium may, by uniform swelling, be changed in some places into a nearly homogeneous mass, which soon falls off entirely. In other cases successive layers of cells are alternately swollen, the swollen layers being recognizable by the greater diameter and lighter tinge of the cells. This proves successive changes in the pathological process which causes the swelling. It is probable that the changes in the epithelium described, edema and swelling, are often very

transient, the liquid becoming absorbed as quickly as it is produced (Fuchs).

"The liquid effused in and between the cells diminishes their coherence, so that the superficial cells fall off. This *desquamation* is never entirely absent in cases of acute corneal disease, its intensity depending on the degree and on the special character of the inflammation, being found *par excellence* in neuro-paralytic keratitis. In the slightest degrees single cells only are exfoliated; in severer cases whole layers of cells are thrown off. The basal cells are then often small and cubical, staining deeply; they are young cells which have to divide so rapidly to replace the loss that they have not time to reach full maturity. After the elimination of the superficial cells the surface is usually uneven, and this also may be a cause of the stippled appearance seen clinically. Rarely the surface remains smooth. If the desquamation increases it may leave behind only the basement layer of cells, which are then either short and cubical or long and thin. In the latter case they are often set obliquely on Bowman's membrane, owing to the pressure of the lids. Desquamation may go so far as to lead to entire loss of the epithelium.

"The effusion between the vacuolation of the deeper cells may lead to the formation of microscopic vesicles. In the same manner larger *cystic spaces* arise, between which the epithelial cells are compressed, so that they become elongated and spindle-shaped, often losing their nuclei and appearing as fibrous walls to the cysts (Klebs)."—(J. D. L.)

Cornea, Endogenous gonorrhea of the. The occurrence of metastatic or endogenous gonorrheic conjunctivitis is today generally accepted. Pincus (*Arch. f. Augenheilk.*, lxxviii, p. 36) reports the case of a woman who had been suffering for several months from gonorrheic urethritis and vaginitis and suddenly noticed an inflammation of her right eye, characterized by a keratitis and circumscribed edema or serous exudation at the lower retrotarsal fold. Repeated examinations of the conjunctival secretion revealed no gonococci. The eye got well in four days, but, on the second day, a painful swelling of the left ankle joint developed.

The number of cases of metastatic gonorrheic keratitis which have been published is small. The few cases reported have answered all the requirements of this diagnosis: first, the existence of urethritis with gonococci; second, other (simultaneous) signs of gonorrheic general infection, in the form of relapsing affections of the joints; third, the absence of gonococci in the conjunctival secretion. One case was a typical example of a gonorrheic general affection lasting for years and

relapsing with each reinfection, constituting a recrudescence of an uncured urethritis.

The affection of the cornea in these cases consisted in disease of the epithelium, vesicular deposits and defects, which spread at first but later on healed rapidly. These conditions bore a certain resemblance to herpes of the cornea. Hence Pincus concludes that the majority of cases of endogenous gonorrheic keratitis show a disease of the corneal epithelium, characterized by more or less extensive detachments, with their sequels. Under almost any form of treatment recovery is speedy, if not complicated by purulent infiltration.

Cornea, Epithelioma of the. Although not as rare as true carcinoma, corneal epithelioma is a most unusual neoplasm. *Primary* epithelioma of the cornea is probably unknown. It occurs as an extension from the limbus where the conjunctival epithelium changes into corneal. The dense fibrous tissue of the cornea does not readily become infiltrated and therefore resists the invasion to a marked degree. Reports of seven cases are to be found in ophthalmic literature, made by the following observers: Snellen, Stellwag, Colsmann, Galezowski, Bossalino, Lagrange, and Treacher Collins. Of this neoplasm Parsons says: "The cases, therefore, of true corneal epitheliomata are extremely rare, and are all open to more or less doubt. It seems probable, however, that the corneal epithelium is capable of malignant proliferation, and that it has but slight tendency to extend deeply (Lagrange). It is rare for epibulbar growths to invade the interior of the eye; epithelioma of the cornea apparently never does. The substantia propria offers some resistance to the invasion, setting up a barrier of embryonic connective tissue around the epithelial cells. The fact that the canal of Schlemm and the anterior perforating vessels lie under the conjunctiva accounts for the fact that the growth never becomes intra-bulbar; added to this is the fact of the intra-ocular pressure which prevents the growth from bursting through elsewhere. Like all tumors, they grow in the direction of least resistance, which in this case is forwards and peripherally.

It is extremely noteworthy that no epithelioma of the uninjured cornea has ever been observed."—(J. D. L.)

Bossalino (*Ann. di Ott.*, Vol. 41, p. 610, 1912) studied an epithelioma which involved more than two-thirds of the corneal surface in a man of seventy-six years. From microscopic study of the enucleated eye, and from consideration of the views of other authors on the same subject, the following conclusions are reached: To epitheliomatous invasion corneal tissue offers greater resistance than do other tissues. The power of resistance resides especially in Bowman's membrane.

The prerequisite for deep extension of such tumors is a transformation of Bowman's membrane into a fibrillary structure.

Cornea, Erosion of the. In cases of so-called corneal erosion, Cuperus (*Arch. f. Augenheilk.*, Vol. 61, No. 1, 1908) always obtained staining by the use of fluorescein, especially if he examined them in the dark-room by focal light. He prefers, therefore, to call this affection *ulcus corneæ superficiale;* for he contends that there is present a tissue defect with an inflamed base, not a clear base as Fuchs has described. Bandaging until the defect no longer stains is generally adequate treatment. Only occasionally is curetting or cauterization necessary. Curdy (*Trans. Am. Ophth. Soc.*, Vol. 11, Pt. 3, 1908) cured a case of this disease, which had proved intractable for a long time, by relieving an epiphora due to lachrymal stricture. The presence of tears in excess may, he suggests, diminish the power of resistance of the cornea.

Cornea, Exhaustion ulcer of the. See **Keratitis, Xerotic.**

Cornea, Facets of the. Circumscribed, flattened areas on the surface of the cornea where small phlyctenulæ or ulcers have existed. They represent a peculiar reparative process, and may be slightly cloudy or entirely transparent.

Cornea, Family degeneration of the. (Fehr.) LATTICE-SHAPED OPACITY. Sometimes, called *grill-like keratitis.* Family degeneration of the cornea, frequently spoken of as a form of keratitis, is of clinical importance on account of the resulting opacity. Roy (*Arch. of Ophth.*, Vol. 41, p. 490, 1911) reports six cases, those of a mother and five children, three sons and two daughters, the condition being more marked in the latter. The father had good sight. The opacity consisted of small opaque dots, mostly massed at the center of the cornea. The surface seemed raised above each dot; but they were only partially removed by curetting, which produced no improvement of vision. No microorganisms were found in them, and all tests for tuberculosis yielded negative results. The older members of the family had always suffered from weak eyes. A son, aged 23, and daughter, aged 20, had never complained, but on examination showed opaque dots of the same character near the centers of their corneæ. Clausen (*Berlin. Ophth. Gesell.*, Feb. 23, 1911. *Ophth. Rev.*, Vol. 30, p. 157, 1911) reports a group of seven cases, a woman, two sisters, a son and daughter of one sister, and a son of the other; and her own granddaughter. The ages ranged from 49 years to 21 months. In all cases the periphery of the cornea was clear. Nothing suggested tubercle or syphilis. Zani (*Ann. di Ott.*, Vol. 40, p. 236, 1911) reports the cases of two sisters thus affected; one, aged

50, had noticed failure of vision for fifteen years; the other, aged 46, presented similar spots. (*Ophthalmic Year-Book,* 1912.) See **Cornea, Lattice-like degeneration of the; Cornea, Nodular opacity of the;** also, **Keratitis, Grill-like.**

Cornea, Fatty degeneration of the. Although the *arcus senilis* was once thought to be a common example of corneal fatty metamorphosis, it is not now so regarded. It is, however, not uncommon in scar tissue of the cornea. It is also seen (Seefelder) in marginal atrophy.

Tertsch (*Klin. Monatsbl. f. Augenh.,* Bd. XLIX, ii, p. 1, 1911) has reported a case of a still rarer tissue change, viz.: *primary* fatty degeneration of the cornea. A man, aged thirty-two, complained of loss of vision following an attack of inflammation five years before. In the center of each cornea there was an elliptical opacity measuring 8 mm. by 9.5 mm., of a dense, saturated-yellow color, quite opaque, denser at its edge than in the center, and composed, under the loupe, of rather coarse spots, with some small white dots among them. The epithelium was stippled but intact. Wassermann and tuberculin reactions were negative.

In a superficial shaving from the area, the deep layers of the epithelium were found to be degenerated, the spaces between the cells being filled with coarse and fine granular material, staining with Sudan III. Similar material was present also in the cells. The membrane of Bowman and the corneal lamellæ were irregular in thickness, having become swollen and homogeneous in places, broken up and fibrillar elsewhere. Dense deposits of fat were present throughout. Since the condition occurred in a healthy person, in both corneæ and there alone, and since the other pathological changes were degenerative, the author believes the condition to be a true degeneration, and not a fatty infiltration.

Takayasu (v. Graefe's *Archiv für Opthalm.,* Vol. lxxxii, pt. 3, August, 1912) has described the microscopical appearances seen in another case. The sections of a piece of cornea removed for pathological investigation were stained with hematoxylin and Sudan III. Bowman's membrane was seen to be broken up at intervals into fibrils, some of which became continuous with the underlying corneal lamellæ, but which for the most part were interwoven to form a network, slight projections being thus caused under the corneal epithelium. Over these projections a compensatory thinning of the epithelium preserved the smoothness of the corneal surface. Scattered here and there throughout the stroma were reddish-yellow areas consisting of fat-globules which were for the most part contained in the lamellæ, but which appeared here and there in the intervals between them

(perhaps pressed out during the preparation of the sections). Fat-globules were present in the protoplasm of the corneal corpuscles, likewise in the broken up fibrils of Bowman's membrane as well as in the bases of the epithelial cells overlying these broken up parts.

This condition occurred in a girl of sixteen who had enjoyed good sight up to the age of ten, since when she had had recurring transient attacks of pain, photophobia, and redness in both eyes. After each attack the vision was permanently less acute than before. Opacities were found over the whole extent of each cornea, excepting only a narrow rim inside the limbus. These opacities were situated in the corneal substance at varying depths and consisted of patches made up of finer dots and lines. A few deep vessels were present, and isolated dotted opacities occurred between the larger patches.

The author describes a second case with a very similar history. This patient was a girl of fourteen in whom, however, only the central parts of the cornea were affected. No detailed pathological examination was made. A small piece of corneal substance was removed with a needle and examined in the fresh condition after staining with Sudan III, and a large number of fat-globules were seen to be present.

Both the patients had suffered from trachoma with pannus, of which they had been cured, but the author does not consider the corneal condition to be in any way connected with this disease. He thinks that the progressive nature of the opacities, together with the absence pathologically of all signs of inflammation, point to a primary degeneration of the cornea. (R. A. Greeves in *Oph. Review,* April, 1913.)

G. Attias (*Klin. Mon. f. Aug.*, 49, II, December, 1911, p. 745) has described another of these rare degenerations, in a poorly nourished infant, aged eight weeks, who presented a keratitis exfoliativa, probably related to keratomalacia. The ocular conjunctiva looked dry; that of the lids was not changed. The corneæ, up to a narrow, peripheral area, were grayish-yellow, apparently in all their layers, with a central ulcer of the right eye. They were dry and insensitive. For about three weeks pieces of the lamellæ, of milky appearance, up to a diameter of 5 mm. were exfoliated until the right cornea perforated, with prolapse of iris, followed by leucoma, and a central macula of the left eye. The disease lasted two months.

The microscopical changes of the sloughed lamellæ showed that the corneal tissue had lost its fibrillar structure and contained larger isolated areas and collections of small fat drops. The parenchyma cells

lacked their processes, and their protoplasm was also homogeneous. Some of these cells contained fat drops.

Cornea, Febrile herpes of the. See **Cornea, Herpes febrilis of the.**

Cornea, Fibroma of the. A number of observers have described cases as fibromata of the cornea, which, according to Parsons, were really hyperplastic scars. This authority says: "The condition develops in old scars in trachoma, in adherent leucoma, etc. These swellings may be localized or diffuse and differ, in no respect, from ordinary pseudo-corneæ, except in the overgrowth of vascular connective tissue. Other observers have reported cases which were apparently true fibromata of the cornea, in which the tumors growing from the central portion of the cornea were pedunculated and polypoid, usually covered with epithelium, which resembles corneal epithelium, but may have mucous cells or be horny on the surface. The growth itself consists of irregular bands of fibrous tissue with scanty flat and round cells. More rarely the bundles are laminated, or as in Rogman's case, the growth consisted of embryonic, spindle-shaped cells."

Ball saw a case of symmetrically placed tumors which proved to be fibromata.—(J. D. L.)

Cornea, Fistula of the. FISTULOUS STAPHYLOMA. A small opening through the cornea, usually the result of a perforating ulcer, establishing a communication with the anterior chamber. This condition, fortunately rare, occurs as a result of an imperfect healing process. If, during cicatrization, the delicate membrane occluding the opening is repeatedly ruptured, the perforation may, at length, remain permanently open and a fistula of the cornea is formed. The fistula then appears under the guise of a small dark point surrounded by whitish cicatricial tissue.

The anterior chamber is usually empty, or filled from time to time, only to be again emptied. The tubular opening, after existing for some time, becomes lined with epithelium; and this prevents its closure. Should the fistula remain open for any length of time, atrophy of the globe or panophthalmitis may follow.

Treatment. The early writers speak of touching the fistula with silver nitrate. De Wecker has reported a cure brought about by using a fine-tooth forceps and tearing the walls of the tubular opening.

Cornwall reports a case cured where the fistula was small and situated near the periphery; he used the point of a jeweler's brooch, bent at right angles, the point being about 1 mm. long. Under cocaine anesthesia this electrode was inserted in the opening, the point

rotated to produce erosion and a one-fourth ma. current was used; after which the eye was bandaged for two days.

Iridectomy and fine corneal sutures have been recommended, but this treatment usually proves futile.

Galvano-cautery is probably the most satisfactory; a very fine, pointed electrode being used, and the epithelial lining destroyed. There is more or less danger to the lens during this procedure.

Ball (*Modern Ophthalmology*, p. 358) suggests that a keratome should be introduced beneath the fistula before using the cautery. It is hardly necessary to state that the anterior chamber must be re-established before this can be done.

The most plausible method of treatment of fistula is to pack the conjunctival sac with a vaseline ointment of arecolin, and keep the lids closed by means of a light compress. As soon as the anterior chamber has been re-established, the epithelial lining of the tubular opening should be thoroughly destroyed. Aqueous will be lost in doing this, but by repacking we can re-establish the anterior chamber until a firm cicatrix is formed.—(H. B. C.)

Hitherto the only recorded examinations of corneal fistulæ have been those published by Czermak (*Arch. of Ophth.*, p. 357, 1909). His cases showed a gross opening leading into a trough-like depression, the inner portion of which was formed by fibrous tissue and the outer by the pigment layer of the iris. In Oguchi's case (Graefe's *Arch. f. Ophth.*, Vol. 70, p. 88, 1910) gonorrheal ophthalmia had resulted in a small perforation, which the pupillary portion of the iris sufficed to fill. The iris had become spongy in texture and the pigment layer was absent. There was no trace of fibrous tissue or scar, but over the thin iris was an incomplete layer of corneal epithelium. The aqueous filtered through the loose iris stroma resulting in bulla formation. There was no gross opening. The author thinks that the appearances observed in his case are characteristic of fistulæ following a small perforation which the pupillary margin completely fills, but if the perforation is large the conditions observed by Czermak will prevail.

Sameh Bey (*Clin. Opht.*, Vol. 19, p. 242, 1912) has often seen corneal fistulæ in association with sluggish ulcers which show merely a small black point surrounded by a grayish scar; and with no anterior chamber on account of the continuous escape of aqueous. He recommends iridectomy for this condition, which he has performed sixty-five times, reporting five cases in detail. He concludes that the iridectomy favors the nutrition of the eye; and is equally efficacious in the treatment of keratocele, in which condition cicatrization and

healing are rapidly brought about. Mueller (*Zeit. f. Augenheilk.*, Vol. 30, p. 457, 1912) advocates the use of the conjunctival flap for corneal fistula, and has produced healing with normal restoration of vision by this method.

Cornea, Fixed cells of the. If a negative silver-stained cornea be placed within the dorsal lymph-sac of a living frog and allowed to remain a few days, it is found that leucocytes in great numbers penetrate it and are seen within the white passages. Recklinghausen therefore distinguished in the cellular elements of the cornea two classes—*fixed cells* that lie in the lymph-lacunæ, and *wandering cells* that pass from place to place along the canaliculi.

Cornea, Foreign bodies in the. Foreign bodies of great variety frequently penetrate and lodge beneath the epithelial layers of the cornea. The usual site is some portion of the inter-palpebral area. Mechanics, whose occupations subject them to exposure, are very frequent sufferers from these accidents. Fragments of coal, cinders, wood, stone, powder grains and small particles of iron are the commonest foreign bodies, the last named being, in their case, the chief offenders. Iron particles are brown or black in appearance, due to oxidization of the heated sparks and the formation of ferrosoferric oxide which impregnates the adjacent corneal tissue as the ferric hydrate develops. At a later period a ring of grayish exudate forms about the foreign bodies.

The writer recently saw a case in which molten lead had struck the cornea. One hour following the accident a small particle of the metal was removed from its attachment to the cornea.

When foreign bodies penetrate the deeper corneal layers the condition assumes a more serious aspect. The resulting scar, when situated in the pupillary area, may markedly impair or practically destroy vision. Infection is always to be feared in deep-penetrating wounds, especially when the affected individual suffers from dacryocystitis, since a serpiginous ulcer or ring abscess of the cornea may destroy the eye. Superficial foreign bodies left to themselves are generally expelled by the softening of the tissues (suppuration). If uncomplicated, the small ulcer heals with a permanent superficial opacity.

Treatment. The removal of foreign bodies from the cornea is accomplished by first rendering the cornea anesthetic with cocaine, or one of its substitutes, and then lifting the object from its attachment with a spud or special needle. The ferric hydrate, which develops about iron sparks, should be carefully cleared away.

When foreign bodies have penetrated the deeper corneal layers,

one must sometimes incise the lamellæ so that the object may be grasped with suitable forceps. In some cases, it becomes necessary to make a preliminary opening at the corneal margin, insert a spatula into the anterior chamber and retain it against the posterior portion of the cornea during extraction. By this means, entrance of the foreign body into the anterior chamber is prevented.

All of the above operative procedures should be done under rigid aseptic conditions. Kuhnt's sliding flaps are often useful to assist the closure of large corneal openings and to prevent complications. —(J. D. L.) See, also, **Injuries of the eye.**

Cornea globosa. KERATOGLOBUS. HYDROPHTHALMOS. BUPHTHALMOS. See page 1339, Vol. II, of this *Encyclopedia.*

Cornea, Greenish discoloration of the. Fleischer (*Ophthalmic Year-Book,* 1911, p. 130) reports that two cases of this peculiar condition have come to autopsy. Peculiar pigment granules were found in Descemet's membrane, the vitreous layer of the choroid, the basal membrane of the uriniferous tubules, the sarcolemma of the muscles, in other connective tissues, as well as in the blood.

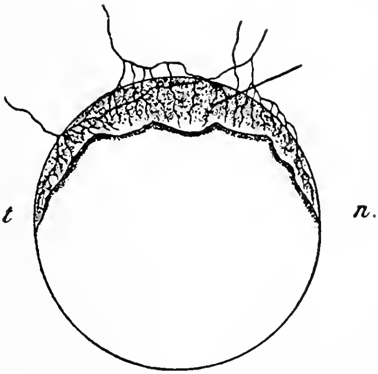
Cornea, Groenouw's disease of the. See **Cornea, Nodular opacity of the.**

Cornea, Groove-formation in the. Fuchs teaches that the cases of groove-formation, in which the groove is peripheral to the arcus senilis, are due to degenerative changes in the arcus; but that grooves located centrally from a gerontoxon have a different etiology and probably an inflammatory one. It appears from Gilbert's three cases (*Klin. Monatsbl. f. Augenheilk.,* Aug., 1908) that the distinction cannot be maintained. These were all cases in which the furrow was situated centrally to the arcus.

He was able to observe in a single eye all the usual stages at once. At one point was a simple gerontoxon gradually becoming furrowed, with the bottom of the groove still showing the waxy color of the arcus; then, farther on, the groove getting transparent, with some yellowish color at the edge, and finally beyond this, the beginning of ectasia. There was no history of any inflammation. In Gilbert's cases the groove was seen to be covered with epithelium, and it did not take the fluorescein stain. Such eyes are of course susceptible to infection; one case had an intercurrent conjunctivitis due to the diplobacillus.

Handmann (*Klin. Monatsbl. f. Augenheilk.,* Sept., 1908) contributes to the evidence against an inflammatory origin the observations made in three cases. The first was in a man aged eighty. The groove was peripheral to the arcus. The lenses were cataractous.

In one eye he removed the lens; fluid vitreous escaped, but vision was finally 5/10. The nerve showed excavation. He calls attention to the frequent occurrence of degenerative changes in the fundus. Changes in the macular region have been reported. Handmann reports a case of a woman, aged thirty-nine, who had suffered from keratitis in recurrent attacks for years. One mm. from the limbus there was a grayish opacity of slightly-wavy outline, furnished with superficial blood vessels. There was no arcus, astigmia, excavation or ectasia, and the vision was 6/5. In Knapp's case (*Arch. of Ophth.*, May, 1908, p. 341) there was a history of inflammations, probably keratitis marginalis, and the patient was forty-four years of age. The situation was typical of the disease, being at the upper inner



Peripheral Groove Formation. (Handmann's Case.)
t, temporal; n, nasal side of cornea. Opacity sharply limited toward center of cornea. Vessels running into it from conjunctiva.

quadrant in each eye. There was an opacity at the upper end of the groove, which at the extremities passed gradually into normal cornea. More reports are needed of cases observed early in the course of the disease, before the question of a possible inflammatory origin can be definitely answered. (*Oph. Year-Book,* 1909.)

Cornea, Guttate opacities of the. (Fuchs.) GRILL-LIKE KERATITIS. FAMILY PUNCTATE DEGENERATION OF THE CORNEA (FEHR). This disease is described by Haab and thought by Darier to be due to an infiltration of the corneal lymph channels by excess of leucocytes. The latter observer recommends for its treatment instillations of dionin (5 per cent.) and subconjunctival injections of sodium chloride (5 per cent.) and of cyanate of mercury 1:5000 with 1 per cent. acoin.

Cornea, Hemachromatosis of the. See **Cornea, Melanosis of the.**

Cornea, Herpes febrilis of the. HERPETIC ULCERS OF THE CORNEA. CATARRHAL HERPES OF THE CORNEA. This disease is an affection of the cornea characterized by the appearance of numerous small, superficial, transparent, eruptive, vesicles in association with febrile diseases. The vesicles are from one-half to one mm. in diameter and contain serous fluid without lymph cells. They are arranged in groups or rows, suggesting a string of beads, and are most frequently observed near the corneal limbus. The ruptured vesicles give rise to superficial ulcers, which may extend uniformly or may vary their course and extend principally in one direction. From the ulcerations, branching gray striæ sometimes appear, extending well into the clear cornea. The vesicles form and rupture rapidly, following which the margins become irregular and ragged in appearance. Indistinct, superficial opacities are noted at the site; these entirely disappear in a short time after the first appearance of the lesions. During their activity the vesicles stain with fluorescein. The corneal eruptions have all the characteristics of those which appear almost simultaneously upon different parts of eyelids, lips, nose and ears, and are vulgarly known as "cold" sores. The ocular, as well as the facial eruptions, are usually confined to one side. The disease is most common during middle and advanced age.

The irritative symptoms of this disease are violent, despite the fact of its superficial nature. Pain, photophobia and lachrymation are very well marked.

Herpes febrilis corneæ appears concomitantly with numerous febrile diseases, especially those affecting the respiratory organs.

The anterior wall of the vesicles is formed by the epithelial layers and Bowman's membrane and the posterior by the substantia propria. Treacher Collins is of the opinion that the vesicles of this disease and those of vesicular keratitis are microscopically identical.

The *treatment* of this disease consists of appropriate internal medication as may be indicated in each instance. Locally, dark glasses or protective bandages are useful as means of controlling the irritative symptoms. Warm compresses and atropine are sometimes helpful. Calomel or dionin will produce beneficial results in some instances. Chemical, or even the actual, cautery may be required to terminate stubborn cases. In nearly every instance the disease is self-limiting, and disappears without treatment.—(J. D. L.)

According to Wood's *System of Ophthalmic Therapeutics*, p. 743, before the vesicles have burst a bandage should be applied to the eye and an ointment of atropine and holocaine used to relieve the photophobia and other ocular discomfort. Von Graefe advises that the small vessels be opened and dusted with calomel. Subsequently hot

applications, the use of ammoniated mercury ointment and aristol applied with an insufflator are in order. Some observers have noticed favorable results from the careful use of the galvano-cautery or from touching the denuded areas with tincture of iodine. This disease is often part of a general dyscrasia which should be properly treated. Most cases are benefited, especially when there are recurrences, by laxatives, quinine and other tonics.

The following salve is also recommended as an application to the vesicles: Ungt. zinci oxidi, 22.50 (℥vj); Boroglyceride, 7.50 (℥ii); Phenol, 1.75 (gr. xxvi).

Cornea, Herpes, Menstrual of the. This affection may be defined as that form of corneal herpes which attacks the patient at the menstrual period. It is not a common affection, but presents characters that properly call for a separate classification. The following are cases in point. A woman, aged forty-two, who had seven children, complained of pain in the right eye and photophobia regularly five days after cessation of the menses of the last four periods. After from two to seven days the eye was normal. There was ciliary injection, the epithelium of the cornea was irregular, due to a large number of prominences which, under the corneal microscope, appeared to be bullæ of 1/5th mm. diameter. The cornea was otherwise clear, excepting some infiltration corresponding to the bullæ. The iris was normal. After subsidence of the bullæ a slight dotted haziness remained in the corneal tissue. H. Roenne (*Klin. Monatsbl. f. Augenheilk.*, March, 1910) regards the eye lesions as a menstrual concomitant and quotes seven other cases from the literature of the subject to substantiate this claim.

G. Mosso (*Annali di Ottal.*, xl, p. 343, 1912) reports the case of a girl of eighteen years, poorly-developed and of probably tuberculous family, whose menstruation had begun only one year previously. She came complaining of intense photophobia, and pains in the left side of the head. The menstrual period had commenced four days earlier. There were a number of vesicles on the upper inner quadrant of the left cornea, and this part of the cornea was hypesthetic. There had been a definite disturbance of the same eye at the preceding menstruation. The corneal lesions ran the usual course of herpes, the patient being discharged after seven days. With the next monthly period came another characteristic attack of herpes, but of shorter duration, and a month later what was probably an abortive attack of similar nature, the same eye being involved on each occasion. Tuberculin test and physical examination were negative, but there was an atrophic ozena especially involving the left side of the nose.

Cornea, Herpes zoster of the. ZONA OPHTHALMICA. This disease appears as a part of herpes zoster ophthalmicus, of which it may be considered a symptom. The ocular complications usually occur when the nasal branch of the trigeminus is involved, a twig that supplies the iris, ciliary body and choroid. Zoster, which is localized about the distribution of the trigeminus, is quite analogous, clinically, to herpes febrilis, but differs in that the course of the former is more severe and the irritative symptoms may continue long after rupture of the vesicles. Anesthesia of the cornea is, in herpes zoster, constant and well marked, and the (neuralgic) pain is more severe, more constant and more persistent. In addition to these characteristic differentiations of the two diseases, the process in herpes zoster is deeper, as indicated by the nepheloid condition of the corneal stroma at the site of the vesicles, where slight nebulous opacities are sometimes permanent. Iritis is not an uncommon accompaniment of herpes zoster corneæ. The small vesicles usually appear on the medial portion of the cornea, often in clusters. They are transparent when forming; later becoming cloudy before they rupture. Following the rupture of these blebs, a superficial ulcer, with irregular borders, is seen at the site of the broken-down vesicles.

To Sattler belongs the credit of first determining the true pathology of herpes zoster ophthalmicus. He ascertained the presence of inflammatory lesions, accompanied by hemorrhage into the Gasserian ganglion, with destruction of the nerve-cells and fibres and the existence of degenerative changes in the branches of the ophthalmic division of the fifth nerve supplying the affected area. It is probably an infection of the ganglion—a true neuritis, also affecting more or less the fifth nerve tissues. Head and Campbell, later, in their studies of the pathology of this disease, verified the findings of Sattler. Local disturbances play no etiological part in this disease, as evidenced by the fact that the cornea at the limbus is rarely involved, a conspicuous feature which does not obtain in ocular diseases influenced by local conditions.

The *symptoms* of herpes zoster corneæ do not differ essentially from those of herpes febrilis corneæ except that they persist, after rupture of the vesicles, and are therefore of longer duration. The neuralgia is persistent and often severe.

Prognosis is not always favorable as regards sight, for, in some cases, nebulous opacities may remain permanently, as the result of the breaking down and infection of the vesicular eruption.

Treatment. A protective bandage is useful. Atropin is indicated to combat iritis when it complicates the disease. Iodoform ointment

has assisted in the control of the process, as has dionin, but the most effective means of rendering the patient comfortable is by frequent instillations of holocain. Opiates (hypodermics of morphia in some cases) are required to mitigate pain. Franke recommends the use of chlorine water, after scraping away the epithelial layer involved in this disease. However, as the disease is but a manifestation of a deeper lesion, local therapeutics alone cannot be otherwise than disappointing. The treatment of the main lesion must not be forgotten. —(J. D. L.) See, also, **Herpes zoster ophthalmicus.**

Cornea, Herpetic ulcer of the. See **Cornea, Herpes febrilis of the.**

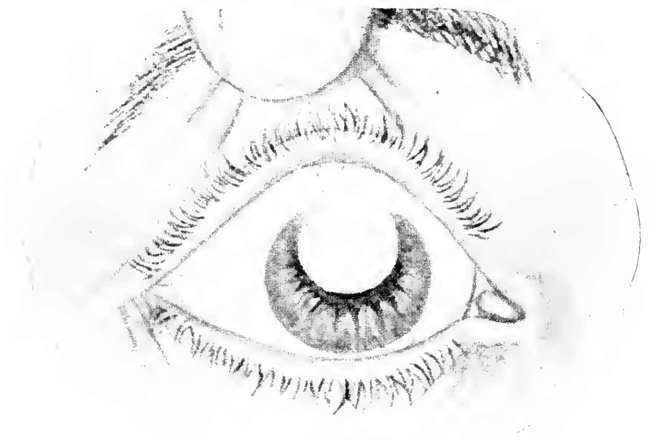
Cornea, Hyaline degeneration of the. This condition occurs in many pathological conditions and is often present in the otherwise normal eyes of the aged. It is not uncommonly present in old corneal leucomata, degenerating anterior staphyloma, after wounds of Descemet's membrane, in eyes afflicted with secondary glaucoma and in nodular and band-shaped opacities. Localized thickenings, hemispherical in form, protruding upon the posterior surface of Descemet's membrane, were first described by Hassall and Henle. Leber regards the punctate opacities (like Descemet's membrane itself), as the products of secretion of the endothelial cells having the characteristics of colloid bodies which sometimes undergo the same calcifying changes. Hyaline substance usually appears in the superficial layers of the cornea, and sometimes the formations project above the surface. As a senile change it sometimes forms on the inner surface of Descemet's membrane; it is usually most pronounced near the periphery. Von Recklinghausen regards it as the "drusen" of one of the several types of hyaline degeneration. It appears in the form of small, hemispherical projections, confined to the lining endothelial cells of the membrane, and are similar to hyaline nodules which are sometimes found on Bruch's membrane. Hyaline is a substance closely allied to amyloid material, and is supposed to be produced by a transformation of the albuminoids.

According to Collins, the histological characteristics of the hyaline material are as follows: "1. Its homogenous structure and highly refractive power. 2. Its insolubility in strong acids and alkalies. 3. Its capacity of staining; deeply with eosine, acid fuchsin, carmine and picrocarmine; lightly with hematoxylin; and of not being turned by iodine."

The staining characteristics of hyaline substances, as described by Parsons, are as follows: "They stain deeply with acid fuchsin and methylene blue, partially or not at all with hematoxylin and carmine. Weigert's fibrin stain colors the granules, not the larger globules, or

only at the edges. Weigert's elastic-tissue stain colors the larger globules red. They stain deeply with Weigert's and Pal's medullary stains. Russel's and Gabbet's stains color the granules deep red, the cells greenish blue or blue. Van Gieson's stain colors the deposits variously—yellow, orange, or brown."

Breselin was the first to demonstrate, in the cornea of a staphylomatous eye, the presenee of amyloid degeneration. Clinically, hyaline deposits appear as deep-yellow spots in an opaque area. Rindfleisch



Hyaline Degeneration of the Cornea. (Wendell Reber.)

(1899) was the first to describe hyaline in a congenitally defective eye. The deposits appeared as translucent, grayish spots.

Wassoaowitsch claims that hyaline degeneration is the result of changes in the endothelium, its derivatives and the tissues connected with it; a theory which Rupert, in his exhaustive study of three cases (*Arch. of Ophthal.*, Vol. XXXIX, No. 4), accepts. Birch-Hirschfeld, who carefully examined four cases of hyaline degeneration, found the peripheral epithelium normal, even at points above the anterior layers of the substantia propria where hyaline deposits were present. Near the center of the cornea, there was marked thickening of the epithelium, which was arranged concentrically or spirally in groups, where deposits, quite homogenous and free from lamination, were present. The deposits between the epithelium and the fibrous tissue stained bright-yellow by van Gieson. Bowman's membrane was ab-

sent, and conical down-growths of epithelium were accompanied by loose cellular connective tissue.

As to the etiology of this degeneration theories are many and varied, but the fundamental cause is probably one of malnutrition.—(J. D. L.)

Wendell Reber (*Ophthalmic Record*, Dec., 1911) believes that deposits of hyaline substance in certain degenerated tissues are by no means rare. On the other hand, hyaline degeneration occurring in a previously normal cornea, seemingly without cause, must be considered rare and its etiology at the present time remains obscure.

The author mentions this unusual condition in a patient, aged fifty, who stated that up to August 1, 1907, her right eye was absolutely normal so far as she knew.

On looking in the glass she discovered a "peculiar looking milky white spot spread out over the upper part of the eye, and when she looked straight forward it barely showed below the lower edge of the upper lid." This would mean that approximately the upper quarter of the cornea and the upper fourth of the pupil area were covered by that time. Yellow salve was ordered for it, but the spot seemed to grow larger.

She was a well-nourished, healthy woman of medium height, good life habits and apparently good metabolism; and the abdominal functions were all well performed.

Vision equaled R. 5/15; L. 5/12. The right eye showed somewhat dilated posterior conjunctival vessels. The cornea was smooth and regular and presented in its upper aspect an irregularly-oval patch about 5 by 7 mm. long, axis 140 degrees. It was of the hue of old ivory or pale mutton-fat, and was smoothly and regularly covered with corneal epithelium everywhere, as Placido's disc showed no distortion in the upper portion of the corneal image. The lower edge of the colored area was sharply defined and reached to the lower third of the pupillary area. The pupil was 4½ mm. in diameter, apparently regularly round and reacted promptly to light (2 mm. reaction). On rotating the eye to the limit upward no iris attachment to the cornea posteriorly could be seen.

The colored area itself seemed to lie directly under the corneal epithelium and at the middle appeared faintly lobulated. Three fine vessels passed on to it at the upper limbus and, under the epithelium, coursed over it. With the Jackson binocular magnifier the lower edge was distinctly crenated, indeed almost finely feathery, and numerous fine globules could be made out in the infiltrate. With the

exception of the few vessels noted the eye was absolutely quiet and the tension normal. The remaining portion of the cornea was perfectly transparent.

The left eye was normal in all respects. She was placed on increasing doses of sodium iodid.

Three months later the corneal condition was unchanged. The iodid was discontinued, and 3 grs. of thyroid substance three times daily substituted for it. One month later she reported, without the slightest change from the condition first described, and she complained so much of the circulatory disturbances set up by the thyroid substance that it was withdrawn. One year later the infiltrate had extended further downward almost to the lower border of the pupil and occupied a perfectly circular space. At this time it looked somewhat like a lens dislocated upward into the anterior chamber, so perfectly round was the infiltrated area. See the illustration. The vascularization at the upper edge was now much more marked, but aside from this there was no sign of irritation about the eye. In fact, the patient had never experienced the slightest twinge of pain since the condition was first observed. The ocular tension was still normal and the iris still seemed uninvolved.

As the patient persistently denied Reber the advantage of laboratory methods in arriving at a diagnosis in this obscure case, he was obliged to depend upon clinical appearances entirely. He would say that it was not a syphilitic phenomenon, as 100 grains of sodium iodid were taken daily for almost four weeks without the slightest appreciable effect upon the corneal condition.

Cornea in exophthalmic goitre. See **Cornea, Sloughing of the,** and **Cornea in Graves' disease.**

Cornea, Infantile ulceration of the. Necrosis corneæ. Keratomalacia. Xerotic keratosis. This rare disease, first described by von Graefe, is confined exclusively to childhood. It usually affects both eyes and is characterized, at its very beginning, by night-blindness (hemeralopia). At twilight the vision shows impairment and, at night, it is almost lost. Hemeralopia, however, is a symptom not easily detected in very young children and in whom, therefore, the first discoverable sign is the dryness (xerosis) of the conjunctiva appearing on both sides of the cornea. Subsequently, the cornea becomes cloudy, lustreless and insensitive, which, along with the affected conjunctival areas, appears as if smeared with grease, and resembles a silvery foam. At the center of the cornea a grayish infiltrate forms which later assumes a yellowish appearance as it rapidly spreads. In severe cases

corneal disintegration develops within a few hours, with softening and sloughing so destructive as to cause complete loss of the cornea.

The inflammatory *symptoms* of keratomalacia are marked and the injection so pronounced as to appear venous in nature, while the irritative symptoms, that is, photophobia, blepharospasm and lachrymation are slight or frequently entirely absent.

This disease accompanies *xerosis epithelialis* of infants. Children developing this affection are usually in poor health or are in the later stages of such exhausting disease as scrofula, measles, scarlet fever or, indeed, any disease which lowers the vitality and renders the cornea more vulnerable, by denutrition, to bacterial invasion. It appears in children suffering from marasmus, as well as those that are weak and emaciated from faulty nutrition and derangement of the alimentary functions. Hereditary lues is another predisposing cause. Most of these children die of exhaustion or of some intercurrent complication, such as bronchitis or pneumonia. This is especially true in very young children. In those who escape a lethal result, the vision is either very markedly impaired or the child becomes totally blind. The impaired nutrition of the cornea is, of course, secondary to the general malnutrition and keratomalacia, but, like many other forms of keratitis, has its inception in an abrasion of a cornea of lowered resistance, permitting invasion of bacteria which, in turn, produces corneal suppuration with its disastrous sequelæ.

The pneumococcus, staphylococcus, streptococcus, xerosis bacillus and the bacillus coli communis have all been found in this disease.

Treatment. In the management of this peculiar corneal disease, attention is naturally directed toward combating the underlying cause. In apathetic patients the cornea should be protected from desiccation by a bandage. When necrosis of the cornea develops, especially in severe cases, treatment is usually unavailing. See, also, **Keratomalacia.**

Cornea, Infected ulcer of the. See **Cornea, Serpent ulcer of the.**

Cornea, Inflammation of the. See **Keratitis in general.**

Cornea in Graves' disease. The anesthesia of the cornea and its liability to various forms of keratitis have been referred to elsewhere. Among additional reports a case of acute purulent keratitis in exophthalmic goiter has been detailed by Juler (*Ophth. Soc. U. K.*, Vol. 33, p. 58, 1912. *Ophthalmoscope*, Vol. 11, p. 456), where the exophthalmos was so extreme as to produce a severe keratitis with hypopyon, necessitating the removal of the globe. The left eye then gradually became involved in a similar manner, the globe becoming immobile, the patient being unable to close the lids without effort. The external canthus

was divided, free incisions made into the orbit, tarsorrhaphy performed after splitting the lid, and the eye thoroughly irrigated. Within a few days the stitches pulled through and the eye was again in danger from the intense pressure. The left superior cervical sympathetic was removed, the orbit again incised, the conjunctiva dissected away from the limbus and sutured over the cornea, and the tarsorrhaphy repeated. The lids were kept in apposition by mattress sutures. After about ten days the sutures gave way and the cornea, which had begun to improve, again got worse; when the entire procedure was repeated. This time the sutures lasted about ten days, but the swelling grew less and the cornea finally healed. In the meantime Roentgen ray treatment of the thyroid had been carried out. The healing of the cornea after having been covered with a conjunctival flap is in line with the treatment advocated by Starr (*Trans. Amer. Acad. Ophth. Oto-Laryngol.*, 1912, p. 17). See, *Conjunctivoplasty*, in **Cornea, Ulcer of the.** Tarsorrhaphy was also performed in a case by Terson and Terson (*Clin. Opht.*, Vol. 19, p. 302, 1912), who were able to save the globe with a large central leucoma in the right eye; but when the left became involved they operated earlier, and kept the cornea covered until out of danger.

See, also, **Cornea, Sloughing of the.**

Cornea, Injuries of the. See **Injuries of the eye.**

Cornea, Internal ulcer of the. It is mainly to von Hippel (Graefe's *Archiv f. Ophthalm.*, 68, 2, 1908) that we are indebted for our knowledge of this (probably) very rare disease. This author reports the microscopical examination of the eye of a child aged thirteen years, the subject of recurrent attacks of interstitial keratitis. An optical iridectomy had been performed four years previous to the excision.

The microscopic investigation left some doubt as to the cause of the keratitis as, although giant cells were present, no tubercle bacilli were found nor did the impregnation method show any spirochetes.

In two places Descemet's membrane was perforated, thus forming an internal ulcer of the cornea.

He also gives an account of the cornea of a still-born child in which there were present various other conditions due to congenital syphilis. In this case numerous spirochetes were found in those parts of the cornea that showed the greatest amount of anatomical change.

Such a case tends, in the opinion of the author, to show that interstitial keratitis is not a metasyphilitic affection, but is directly due to the action of the parasite.

Von Hippel believes that such ulcers may explain the occurrence of congenital staphyloma and leucoma. The fact that the iris may

become adherent to the back of the cornea in no way invalidates this theory, as it will be possible in such circumstances to get the formation of a leucoma with deep anterior chamber or a staphyloma with obliteration of the anterior chamber.

He is willing to admit that all such cases need not be preceded by a genuine internal ulcer, as other congenital inflammatory processes of the deeper layers of the cornea may lead to ectasia of that structure.

The important point demonstrated is that staphyloma and adherent leucoma may exist without superficial ulceration, perforation, or even purulent softening of the cornea. The establishment of this fact renders the explanation of congenital defects of this nature more simple.

It is to be noted that in these cases, as in most of those in which an internal ulcer of the cornea has been discovered anatomically, the tension has been raised.—(E. E. Henderson, in *Ophth. Review,* August, 1908.)

Meller (Graefe's *Arch. f. Ophth.,* Vol. 72, p. 456, 1909) reports the first case of internal ulcer of the cornea actually observed. There has been confusion among writers concerning the nature of the disease. Stock, Stanculeanu and others attribute the presence of scar tissue on the posterior surface of the cornea and communicating with the parenchyma to a previous internal ulcer, while v. Hippel referred to the same cause, two cases in which there was no fibrous tissue, but simply a defect in the membrane of Descemet and a parenchymatous opacity. Meller discovered an ulceration in progress upon the posterior surface of the cornea in an eye enucleated for endophthalmitis. The anterior chamber was filled with pus. The direct cause of the ulceration may have been direct infection by pathogenic bacteria, but it might have occurred by histolysis from a bacteria-free exudate. He concludes that internal ulcer of the cornea is not to be spoken of as a definite pathological entity, but is an accidental condition as a sequel to corneal or iritic disease. He is inclined to grant that the cases of Stock and others, in which fibrous tissue was found filling a defect in the posterior layers of the cornea, were the result of an internal ulceration although, as they occurred in eyes that had long been blind, the tissue may have originated in a degenerative pannus. The cases of parenchymatous opacity and defect of Descemet's membrane without scar formation, he thinks, are etiologically different, agreeing with Peters (*Centralbl. f. p. Augenheilk.,* p. 351, 1909) that they are probably the result of arrested development. Valenti (*Ann. d'Ocul.,* Vol. 141, p. 460, 1909) has observed internal ulcer of the cornea supposed to be due to the toxins of syphilis.

Cornea, Keloid of the. This is an exceptionally rare affection of the cornea; only three cases having been reported, one by R. Simon, one by Szokalski and the other by Wescott, whose case, in an infant, was associated with corneal staphyloma.—(J. D. L.)

Cornea, Lattice-shaped opacity of the. (Fuchs.) Grill-like keratitis. Reticular opacities of the cornea. This corneal opacity is distinguished from nodular opacity principally by the presence of radiating and intersecting linear opacities passing through the dust-like, gray dots, which form a fine net-work, presenting altogether the appearance of a cobweb. Like nodular opacity of the cornea, the affected site corresponds to the pupillary area, where elevations of the superficial layers of the epithelium, and probably of Bowman's membrane, occur. As in nodular opacity, hyaline material has been found in the opacities.

This disease begins about the age of puberty and affects both eyes. It pursues a slow and chronic course, while the opacities continue to increase in number and density. Several members of the same family are often affected, a fact that strongly suggests an hereditary influence. Sometimes slight inflammatory symptoms occur at intervals.

Treatment. Darier recommends dionin and subconjunctival injections of sodium chlorid, and claims marked beneficial results from their use.—(J. D. L.)

Heinrich Freund (*Wiener Klin.-Therapeut. Wochenschr.*, Feb. 28, 1904) reports fifteen cases of this very rare affection, which he himself had examined and observed for a long period. Until his report there were only ten cases of this disease detailed in literature (Biber, Haab, Dimmer).

In the first stage only a few single knot-like elevations in or around the center of the cornea are observed; these correspond to the smallest, light-gray, cloudy spots, which lie under the epithelium. Even at this stage a faint, bluish-gray cloudiness may be observed in the center of the cornea, which, when examined with a magnifying glass, will show a meshwork consisting of fine, grayish-blue, knotty, irregularly crossing lines; and it is from this grating-like appearance of the cloudiness that the disease derives its name. Alongside of these, however, mostly in the periphery, there are numerous radiating grayish lines thickly placed under the epithelium which by trans-illumination appear deep black.

Subjectively, besides quite marked diminution in vision, there is dryness of the eyes, and a troublesome dazzling. In the course of the disease all these appearances increase or diminish more or less, until about the fortieth year, but the margins of the cornea are always

spared. In some of the cases this picture remains unchanged at this stage; in others there begin painful inflammatory phenomena. In these latter cases the epithelium over the knots degenerates; parts of the degenerated epithelium fall off, with a consequent keratitis. Often after a number of years these inflammatory phenomena disappear, leaving a more or less thick corneal cicatrization.

Anatomically there seems to be a formation of gaps and hyaline degeneration of the cornea. As far as *treatment* is concerned the progress of the disease cannot be checked by any measures, not even by abrasion of the cornea.

The disease must be differentiated from the knot-shaped cloudiness of the cornea described by Groenouw and Fuchs. Freund recites the distinctive features of the disease. Grayish, superficial spots within and around the center of the cornea; these latter become thick and elevate unevenly the surface of the cornea; diffuse cloudiness of the cornea, which when examined with a magnifying glass seems to resolve itself into a grated-like network; the margins of the cornea are never affected.

In a case seen by Kipp (*Trans. Amer. Ophth. Soc.*, XI, pt. 3, 1908), a robust man aged thirty, the patient for a month previously had suffered from pain and photophobia. There was ciliary injection and the lids were excoriated. In the center of the cornea spots were to be seen with radiating lines. These opacities were apparently localized in the outer layers. The surface appeared to be raised. The epithelium was intact and lustrous. Blood vessels were absent, sensibility was good, and there was no uveal involvement. As in the cases previously reported, the margin of the cornea was left clear. The family history was negative. When first observed the opacities had a radiating arrangement, but later they disposed themselves concentrically.

Cornea, Lead incrustations of the. The continued use of subacetate of lead, or of any other soluble lead salt, either in the form of ointment, compresses or instillations, may produce in the *substantia propria* of an abraded or ulcerated cornea an intense white, permanent opacity at the site of the break in the tissues. The opacification is due to deposits of (usually) carbonate of lead which impregnate the tissues at the site of the lesion, as well as some of the adjacent deeper corneal layers.

The *treatment* of this condition is the same as that recommended for lime incrustations of the cornea (q. v.).—(J. D. L.)

Cornea, Lepra of the. CORNEAL LEPROSY. LEPROUS KERATITIS. LEPROMA OF THE CORNEA. This extremely uncommon disease resembles

tuberculosis. It usually occurs as an extension from the conjunctival or episcleral tissue and attacks the margin of the cornea, from which point it slowly encroaches upon the more central areas as a crescentic opacity of varying depth. In some cases it extends over the entire cornea (Babés), with sloughing of all the corneal tissue down to Descemet's membrane, ultimately destroying the eye by atrophy. The opacity is white and dotted with numerous small yellowish deposits, or it may develop as distinct nodules. The infiltration, which appears in the parenchyma, usually breaks down into an ulceration. The *superficial form* originates at the limbus under the epithelium as small nodules which are translucent and nonvascular. The nodules consist of agglomerations of lepra cells ("globi") and clusters of bacillus leprosa. The process gradually extends towards the center of the cornea.

The *deep form* resembles sclerosing keratitis or a tuberculous process. This form is preceded by anterior uveitis, the infection reaching the cornea through the episcleral vessels. The process in the deep form shows little tendency to clear up and a permanent discoloration remains.—(Parsons.)

Several cases have been described in which the process was very active and attended by the development of exuberant granulation tissue, forming a tumor-like mass, termed a *leproma*.

Treatment. Several cures have been reported following X-ray exposures. Schirmer advocates section through the entire cornea in front of the opacity, claiming that the resulting cicatrix checks further progress of the disease.—(J. D. L.)

According to Karnitsky and Weinstein (*Klin. Monatsbl. f. Augenheilk.*, Mar., 1909, p. 253), *leproma* is never primary, but extends from nodules in the episclera or from the canal of Schlemm. In case they take their origin from the former structure, nodules form which raise the surface of the cornea; but if the invasion comes by way of Schlemm's canal, deep infiltrates appear in front of the membrane of Descemet. In the case which they report the leproma occupied two-thirds of the cornea and the neighboring sclera. The tumor was very vascular and consisted of round, spindle-shaped and epithelioid cells, covered with numerous layers of epithelium, probably corneal, which grew into the depths of the tumor. The bacilli of Hansen were present in large numbers. The case reported is typical of the eye complications of lepra tuberosa. In the nervous form the corneal infiltration is torpid in character, iritis is present, and there may be lagophthalmos keratitis. As quoted by these authors, Borthen found the eyes

affected in 75 per cent. of the cases of lepra maculo-anesthetica, and in 90 per cent. of the cases of lepra tuberosa.

Roche (*Rec. d'Opht.*, p. 115, 1908) observed a case of leprous keratitis which was symmetrical. The corneal infiltrate had the appearance of fat, and extended from the limbus to the center of the cornea, gradually lessening until it ended in a vertical line. It was at first rapid in developing, but had remained stationary for about four years.

According to Fernandez (*Ophthalmology*, Vol. 8, p. 143, 1911), although leproma of the cornea is very rare, leprous keratitis is very frequent. It begins by extension from the limbus into one corneal quadrant, advancing towards the center, and finally involving the whole cornea. It is attended by severe pain, being quite exceptional among leprous lesions in this respect. Ulceration may occur. The cornea finally becomes very white and somewhat thinned. The advance of the corneal lesion is very slow, but cannot be checked. One eye becomes affected and then the other.

Trantas (*Arch. d'Opht.*, p. 193, 1911) believes that punctate keratitis frequently occurs in leprosy, and is truly leprous in character. It may be epithelial, subepithelial, or deep. It attends both the tubercular and the maculo-anesthetic varieties of leprosy. Superficial grattage gives valuable assistance in the diagnosis, although the lepra bacillus may not always be found.

Cornea, Leucoma of the. See **Cornea, Opacity of the.**

Cornealfalz. Corneal groove (q. v.).

Corneal graft. A portion of cornea removed from an animal's eye by a delicate circular knife and transferred to an aperture of similar size cut in an opaque cornea.

Corneal groove. Where the innermost edge of the bevel-like sclera overlaps the cornea there is a regular setting or groove for it like the metal rim that holds a watch crystal in place; hence this term.

Cornea, Lime incrustations of. These are usually the result of mortar or slaking lime entering the eye, which produce a permanent corneal opacity, due to a deposit of various salts of calcium. Calcareous opacities show no tendencies to clear up.

Treatment. The experiments of H. Guillery determined that corneal opacities, due to deposits of calcium albuminate, are soluble in ammonia chloride, to a 10 per cent. solution of which was added 0.02 to 0.1 per cent. tartaric acid. Cocaine is first instilled into the eye, to obviate the burning sensation and render the ammonium tartarate more effective by its loosening effect upon the corneal epithelium. The solution is used in an eye bath (which acts in about three-quarters of an hour), beginning with a 2 per cent. solution,

increased to 10 or even to 20 per cent. strength. This method is followed by considerable absorption of the deposits and improvement in vision.—(J. D. L.)

Corneal immunity. This subject is generally treated on page 857, Vol. II, of this *Encyclopedia*. Here it may be added that in experimenting on rabbits, Gebb (*Arch. f. Augenheilk.*, Vol. 69, pp. 77, 137, 1911) found that passive immunization against the bacillus suisepticus improved the results after corneal inoculation in proportion to the amounts of serum injected; and that the immunizing serum obtained from rabbits is better than that obtained from other animals. Active immunization from injections twelve days before inoculation did not prevent infection, but was followed by rapid and favorable healing, and where two such immunizing injections had been given the result was still better. Zade (Graefe's *Arch. f. Ophth.*, Vol. 82, p. 183, 1911) found that the rabbit cornea normally contains opsonins, but to a much less degree than the blood-serum. The amount was greatly increased by paracentesis. He found the cornea better qualified for the passage of antibodies than the normal aqueous. By injection of corneal emulsion into rabbits, Kraupa (Graefe's *Arch. f. Ophth.*, Vol. 80, p. 489, 1911) developed an antigen specific for the organ, but not for the genus. Wessely (*Münch. Med. Woch.*, Aug. 8, 1912, p. 1713; *Ann. of Ophth.*, Vol. 21, p. 131, 1911) finds it easy to develop anaphylaxis in the cornea of the rabbit. The reaction is in the form of a parenchymatous keratitis.

Corneal intervals. As shown by the picture on page 376, Vol. I, of this *Encyclopedia*, the sclera has two "weak" areas—or portions where the scleral tissue is entirely wanting, known as "intervals." The one in front, where the cornea is placed, is known as the corneal interval—*anterior scleral foramen; foramen scleræ anterius; foramen corneæ; rima cornealis.* The other is behind, where the optic nerve enters the optic foramen or canal, and corresponds to the optic papilla.

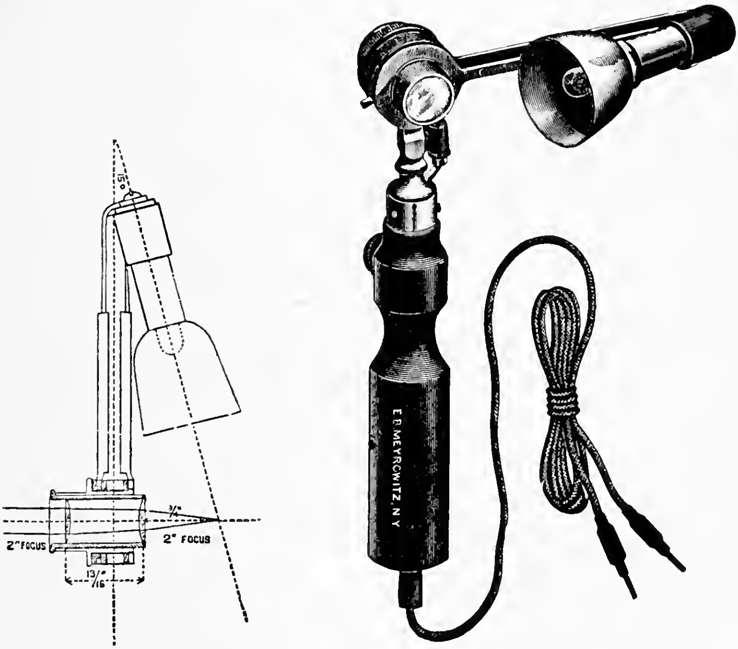
Corneal loupe. Corneal microscope. The examination of the cornea by various forms of the corneal microscope has been referred to in these volumes several times. The loupes of Berger, Aubert, Jackson and others will be described under their several captions and still others under the present heading.

See, in addition, page 958, Vol. II, under **Binocular corneal loupe.**

Quite large numbers of these instruments are now on the market, from simple lenses, like Berger's binocular loupe, to veritable microscopes. Several of these are pictured here.

According to the manufacturer, in Koller's loupe the advantage of combining condenser and magnifying glass in proper relative

positions is obvious, for whatever object is then brought into the focus of the magnifying glass it receives its proper illumination from the condenser. In the instrument a 1 inch lens has been used, at one side of which a parabolic reflector is attached, so that its axis passes through the focus of the lens, intersecting the optical axis at an angle of 80 degrees—a small incandescent lamp in the focus of the paraboloid acts as source of light. The illumination is to come from the temporal side, and, therefore, is made reversible for use on either eye. The



Koller's Corneal Loupe.

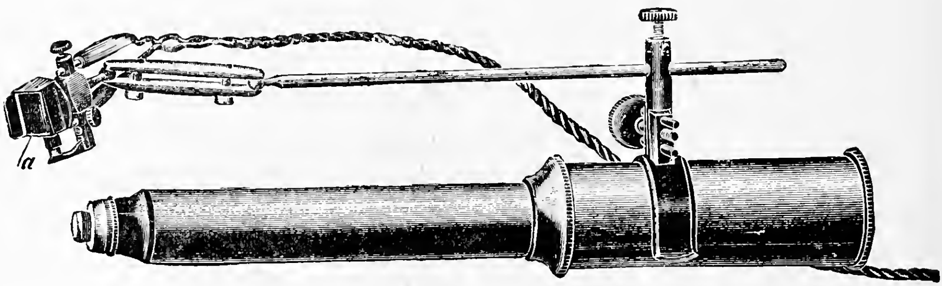
enlargement obtained is 12-14, compared with ordinary reading distance; the field of vision is very large; the handling of the instrument perfectly simple. On examining the anterior segment of the eye one is struck by the wealth of detail to be observed, and by the ease with which pathological conditions of the cornea, iris and anterior part of the lens can be detected and studied.

The electric lamp furnished with this loupe requires 6 volts for its illumination. It can be operated by any style battery giving this amount of current, or it can be used in connection with the incandescent light current if a suitable rheostat is interposed in the circuit. The

lamps are made with a screw base which permits their being readily replaced.

The so-called Baum-Sydow corneal microscope (see the figure) is arranged on much the same principles as Koller's loupe. It is free from corneal reflex and is capable of a magnification of 80 diameters.

The Hardy-Gradle corneal microscope is an attachment of the Hardy ophthalmometer. By its use a magnified image of the anterior aspects of the eye, especially of the cornea, may be obtained. It is attached by removing the cone-shaped tube containing the prisms and objectives and inserting in their place the tube of the microscope. The instrument is then focused upon the eye and in the same manner as is the ophthalmometer. The diagnosis of various corneal conditions,



Attachable Corneal Microscope. (Baum-Sydow.)

such as ulcers, etc., is simplified and changes in the iris or reactions of the pupil are plainly manifest.

It is of particular value in discovering the presence and the exact position of foreign bodies, such as pieces of steel, etc., that may have become imbedded in the cornea. The illumination of the eye can be varied from the direct to the oblique type by simply changing the position of the lamp upon the sliding arc. The intensity of the illumination can be varied at will by changing the position of the condensing lens in front of the lamp. The illumination is produced by an electric lamp of 110 volts.

The corneal microscope of Czapski is an instrument in which binocular vision is obtained, not by a division of light passing through a single objective, but by a combination of two microscopes, each complete in itself. Each of the component microscopes consists of objective and eye-piece in combination with a Porro prism. The use of the Porro prism, already famous in field-glass construction, permits the use of a much shorter tube length and secures a larger field than

would be possible otherwise, except by a much more bulky and inconvenient design.

Interpupillary distances between 56-76 mm. ($2\frac{1}{4}$ to 3 inches) may be obtained by means of the eccentric movement imparted to the eyepieces by rotating the casings of the Porro prisms to which they are attached.

The pairs of objectives are mounted on slides and the mount of one

Hardy-Gradle Corneal Microscope.

of the lenses is provided with a screw thread to facilitate the securing of an equally sharp focus with both lenses where inequalities in the power of vision of two eyes require compensation.

Manipulation of the instrument is made easy and positive by means of the mechanical design. The double tube with its illuminator is carried on an upright column, and by means of a double joint may be rotated vertically or horizontally and clamped in any position. A rack-and-pinion movement serves to raise or lower the instrument and a second similar movement is provided for focusing. The instrument rests on a substantial metal tripod.

The lighting attachment, which is independently adjustable, consists of a small 6-volt lamp mounted in a tube with a reflector.

The base and head-rest are after designs of Eversbusch, and are provided with a movable bed-plate on which the tripod of the micro-

Czapski's Corneal Microscope.

scope rests. This plate, and with it the stand, is moved forward and backward directly by hand and from side to side by a milled head, which operates a rack-and-pinion movement.

The relief effects observed in the images, the good illumination, the comparatively large object distance, the facilities for compensating

inequalities in the power of vision and the large range of interpupillary distance combine to give this microscope great value in eye work.

This instrument is the product of the Carl Zeiss Optische Werkstätte at Jena.

Corneal magnifier. See **Corneal loupe.**

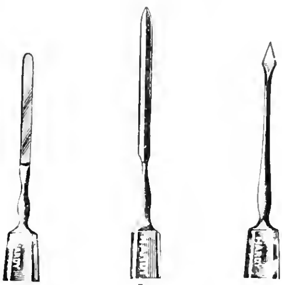
Corneal masseur, Morton's. This is a simple instrument, as the figure shows, for direct massage of the eye, and may be used for several purposes, including stroking of the cornea after cataract extraction, iridectomies, etc.

Morton's Corneal Masseur.

Corneal microscope. A microscope, so constructed as to give an enlarged view of the cornea and iris. See **Corneal loupe.**

Corneal plaques. These are slightly-raised, greyish patches, with rough and feebly vascular surfaces, found occasionally in Indian patients close to the lower margin of the cornea. General pannus was found associated in only a few instances. Apart from the curious shape of some of the patches, the chief point of interest is the etiology of the condition. The patches appear usually to be due to abnormal exposure of this strip of cornea in the presence of chronic conjunctivitis, trachomatous or simple. But the cause of the defective closure of the lids was often obscure.

Corneal spud. An instrument for the removal of foreign bodies imbedded in the cornea. For this purpose a narrow-bladed, sharp



a *b* *c*

Various forms of the Corneal Spud.
a, Dix's spud; *b*, grooved spud; *c*, spear-shaped spud.

pointed Graefe knife is as good an instrument as can be found, but very practical models of Dix, Todd, Becker and others are here illustrated.

F. C. Todd's instrument (*The Ophthalmic Record,* May, 1906, p. 208) is made with a V- or U-shaped groove, beveled on the flat, at several angles.

A. Schapringer (*Am. Jour. of Ophthal.,* Oct., 1884, p. 200) has invented a small scoop about 3 mm. long, attached transversely to the shaft of the instrument.

Corneal stroma. The corneal substance proper, or *substantia propria corneæ.* See **Anatomy of the eye.**

Corneal suture in cataract extraction. From time to time ophthalmic surgeons have sought some satisfactory means of closing the corneal wound after cataract extraction by mechanical means; among them direct *suture of the corneal wound.* This subject is partially discussed under **Cataract, Senile** (see page 1705, Vol. III of this *Encyclopedia*), but it is proposed here to deal with it more fully, in conjunction with the views of E. C. Ellett (*Journal A. M. A.,* Sept. 21, 1912), who has had considerable experience of the method.

The first published description of such attempts is that of H. W. Williams of Boston, who *sutured the corneal wound* after extraction of cataract, and reported favorable results. He later modified this to the extent of placing the suture in the conjunctiva only. We occasionally see reports of similar efforts, but as this method is resorted to after the completion of the operation, it has seemed objectionable, in that if a cataract extraction has been completed successfully most surgeons are willing to omit any finishing touches, especially as a well-made conjunctival flap quickly smooths itself out and adheres to the sclera without other assistance than the pressure of the lid. If the operation has not been satisfactorily accomplished, and especially if there has been loss of vitreous, the surgeon is even more anxious to close the eye without the addition of any manipulation that can be omitted. For this, or other reasons, suture of the conjunctival flap has never been popular. The first attempts at corneal suture, also accomplished after completion of the extraction, were open to the same objections.

Probably with the idea of avoiding these objections, Suarez de Mendoza devised a plan of introducing a suture into the cornea before making the corneal incision, and in 1889 and 1891 published reports of thirty-eight operations performed in this manner. He made a shallow incision into the surface of the cornea about where the incision for the extraction of the cataract would fall, and then passed the suture through the lips of this groove, the loop of the suture being drawn well out to escape being cut. The incision was then made to face in this shallow groove. After the extraction the suture was tied. It

will be seen that this suture did not penetrate the cornea, but was passed into it only, and was not open to the objections that would apply to a through and through suture.

The most noteworthy work by far with the corneal suture as a step in cataract extraction is that of Kalt of Paris. His publications on the subject consist of two papers, dated 1894 and 1910. In the first one the results in fifty cases are given, while the second paper gives 2,000.

Kalt (*Arch. d'Ophtal.*, 1894, xxiii, 421; *Ann. d'ocul.*, June, 1910) thus describes the steps of his operation: "The suture consists of a vertical corneal portion and a transverse episcleral portion. The whole forms a T, with a gap between the junction of the horizontal portion with the vertical portion. The length of each of these portions does not exceed 1 mm. The vertical intracorneal branch follows the vertical corneal meridian and stops exactly at the juncture of the transparent portion with the sclera. The horizontal portion traverses the opaque part of the limbus as near the cornea as possible. An interval of 0.5 mm., corresponding to the limbus, is ample to permit the passage of the knife."

The corneal portion (vertical) is passed first. The loop of the suture is left long and laid to one side, and if wet will adhere to the skin, or to the gauze with which the skin is covered, and not get tangled. In passing the knife, the incision may be completed in an oblique meridian of the cornea instead of the vertical, thus rendering the cutting of the thread less likely. The corneal incision, capsulotomy and delivery of the lens being completed, the thread is drawn by pulling on its upper (scleral) branch, and a square knot is tied. If this suture is well placed, and the points are close to each other, tying does not cause much folding of the cornea, but it is of no matter if it does, as the post-operative astigmatism is not affected thereby. Prolapse of iris and vitreous, if they occur, are reduced by tying the suture and thus approximating the corneal wound. The knot once tied, one is master of the situation. Cortical masses are removed with a suction aspirator, and the iris smoothed into place without fear of provoking loss of vitreous. Physostigmin (eserin) may be used when the iris tends to prolapse, but is not as a rule required. The dressing is monocular, and patients get up on the second day. The stitch is removed on the second or third day, usually the latter.

Nearly every one who has written concerning the corneal suture speaks of the *difficulty of introducing* it, that it adds a step to the operation, and that its removal is a second operation. Thus Van Lint says that it is "an operation which is difficult of execution,"

and others say the same thing; but the proper materials must be used, in which case the corneal suture is surprisingly easy. The proper needle and thread must be employed, however, and here it might be said that the suggestion to employ an absorbable suture is based on theoretical reasons only, as the finest catgut obtainable will not pass through the eye of the right sort of needle. Kalt advises cotton.

It is not necessary to tell the patient that his eye is being sewed up. While it may be the operator's five hundredth extraction, the patient has had no such extensive experience, and does not readily detect slight variations from the usual technic. So when the time comes for its removal, the eye can be cocainized and the patient then told that there is a thread to come out, the lid raised and the suture cut and removed in less time than it takes to tell of it. Accustomed as he is to hear of wounds being sewed, it will seem most natural to the patient that this wound has been treated in that manner. Many people dread the removal of stitches more than they do an operation, and it is well not to alarm them by telling them that there is a stitch in the eye that must come out on such and such a day. All this seems a trivial matter to discuss, but it is the answer to the objection that removal of the stitch is a second operation. At least it is not so unless the operator chooses to make it so.

In tying the stitch there is an advantage in producing a slight wrinkling of the cornea, as by this means one can be sure that good apposition is secured. Not only is this wrinkling temporary, but it even passes off under the pressure of the aqueous when the anterior chamber reforms. A loosely tied stitch, such as some have practised, is of no advantage at all, as without some tension on the edges of the wound, they only lie in apposition just as they would do without any stitch.

The stitch should be removed as soon as the corneal wound is well adhered, which can safely be considered as about twenty-four hours after the anterior chamber is reformed. This gives a good margin, and will be as a rule on the third day. Stitches are foreign bodies and should be removed from every tissue at the earliest possible moment, not only in eye surgery, but elsewhere. To permit them to remain is to invite irritation and infection, neither of which seems to occur when the stitch is removed as soon as Kalt advises.

The only *accidents* likely to happen, besides the ones common to all cataract extractions, are cutting the stitch in making the corneal incision and tearing out the stitch in removing the speculum. Kalt cuts the stitch in 1 per cent. of cases, and in the series of cases herewith

presented it was cut twice. It can be replaced by passing the needle through the same hole, which is easier to do than it sounds, and is what Kalt advises.

If the thread is not kept carefully laid out the loop may catch in the speculum and be torn out in removing that instrument, as occurred in one instance. It must be understood that this can occur only when the speculum is removed before the suture is tied. If the patient does not tend to squeeze and there is no threatening vitreous prolapse, the speculum is left in until the lens is removed and the thread tied and cut off. In the event of this accident it is best to pull out the other branch of the stitch and complete the operation without it. Both of these accidents can be avoided if the whole procedure is carefully conducted.

A signal advantage of the stitch is in *cases of prolapse of iris and vitreous*, especially the latter, at the time of operation. The usual precautions for removal of the speculum and control of the lids by other methods are to be followed, but nevertheless sometimes a large vitreous bead will protrude from the wound. No one who has ever seen this gently retire into the ball as the stitch is tightened will need any other argument to convince him of the value of the stitch, at least under these circumstances. As it cannot be foretold when this accident will happen it is well to be prepared for it in every case.

The control of primary iris prolapse is not so satisfactory, but certainly the replaced iris is more apt to stay replaced when the corneal wound is closed by mechanical means. In this operation the fact that the incision is in corneal tissue and well in front of the plane of the iris makes prolapse of the iris less likely to occur than when the incision is further back, as in the ordinary section with the conjunctival flap.

A great advantage of the corneal stitch is in the facility it affords to the making of a deliberate, careful and *thorough toilet of the wound.* After the delivery of the lens and tying of the stitch, we can, by irrigation, suction and manipulation, get a perfectly clear pupil—clearer than by any other means. Without the stitch one hesitates to do much in this direction if there has been vitreous prolapse, and if there has not been, the manipulations of the toilet often provoke a tendency to "squeeze" which results in prolapse. Certainly nothing contributes so much to a speedy and uneventful healing as removal of cortical flakes and tags of capsule, and their retention within the eye leads to prolonged convalescence and irritation, if not destructive plastic inflammation.

The suction apparatus is the means usually employed by Kalt, but

irrigation is also very safe and satisfactory. The tip of the irrigator is introduced into the anterior chamber at one side of the stitch, while a spatula depresses the scleral lip of the wound on the other side of the stitch, to afford a free outflow of the irrigating fluid and the cortical matter and blood which it expels. It might be noted incidentally that the possibility of this thorough toilet makes the removal of immature cataract a much more satisfactory procedure than when it is extracted in the ordinary way.

The stitch is not a sure *protection against secondary prolapse.* Kalt has observed it in 3 per cent. of the last 1,100 cases which he reports, while the percentage in this series of cases is much higher, namely, 9⅓ per cent., owing, presumably, in part at least, to lack of skill. After an ordinary simple extraction prolapse of iris is the most frequent complication, and occurs in about 10 per cent. to 12 per cent. of cases. When it does occur it tends to rapidly assume large proportions, and its removal is a more formidable procedure in many cases than the extraction of the cataract. The iris quickly adheres to the lips of the wound, and iridectomy under these circumstances is far from easy, and the result is not satisfactory to our esthetic sense. Rarely does one see under these circumstances a clear coloboma, with pillars straight and not entangled in the corneal wound. Without offering an explanation of the difference, it can only be said that the prolapse after suture of the cornea is not only small—limited to one side of the stitch—but does not tend to inflame and quickly adhere to the wound. Its removal, therefore, is easy, and the pillars of the coloboma are more easily replaced, leaving the wound free.

The *course of healing* after operation with corneal suture does not differ materially from that after other methods of extraction. Infection, iridocyclitis and other complications are possible, but it can only be said that in this series they did not occur. The stitch does not seem to cause any irritation; that is, there is no complaint as of a foreign body, such as one might expect. There is certainly no more redness or secretion than after the operation without corneal suture.

It has been said that the stitch would be apt to become infected, but in this series of cases it did not occur. Cleanliness in every detail in the operation and early removal of the stitch are the best safeguards against infection or post-operative reaction. The freedom from cortical débris, more easily secured by this method than by others, in my experience, favors a quick and uneventful convalescence. In cases in which this is true, secondary cataract is of course not frequent, and equally as a matter of course, this follows, no matter what method of extraction is employed.

In speaking of *results*, the visual acuity need not be considered, since no one would expect that better visual results will follow a successful extraction by one method than those obtained by another. Nor does it seem to be the rule that better visual results follow the simple extraction than those obtained by the combined method. The surgical results are very good in operations in which the corneal suture is used. There is a speedier convalescence, the pupil is clearer, and there is therefore less tendency to secondary cataract; the early closing of the wound permits the patient to get out of bed sooner and have the eye not operated on left uncovered, and the early closure of the wound is also a safeguard, although but relative, against infection.

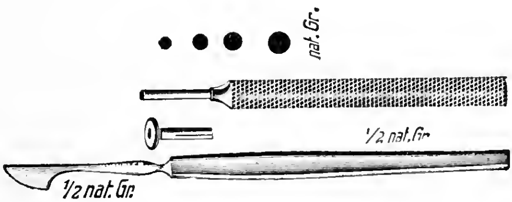
Corneal trephine, Bowman's. This is a hand drill (rotated by the finger and thumb) intended to excise a circular portion of the apex of a conical cornea. The instruments vary in diameter, so as to remove portions of different sizes, as required. They are also provided with a movable "stop," to regulate the depth of penetration.

Corneal trephine, Elliot's. See **Glaucoma.**

Corneal trephine, Pusey's. This little instrument, employed in trepanation for glaucoma, has a guard for the circular knife.

Brown Pusey's Corneal Trephine.

Corneal trephine, Schnaudigel's. The use of this instrument can best be understood by consulting the accompanying illustration. There



Schnaudigel's Corneal Trephine.
The four black circles show the full size of the knives.

are four sizes ($1\frac{1}{2}$, 2, $2\frac{1}{2}$ and 3 mm.) of trephine knives with a protecting collar. There is also a special knife for dealing with the conjunctiva. See **Glaucoma.**

Corneal trephine, Stephenson's. This instrument has a milled handle, as seen in the cut, and is rotated by thumb and fingers.

Stephenson's Corneal Trephine.

Corneal trephine, von Hippel's. See **Cornea, Transplantation of the.**

Corneal tubes. Bowman found that after injecting mercury by gentle pressure beneath the margin of the cornea, certain tubular passages appear, to which he gave this name.

Cornea lucida. A name for the cornea as a whole.

Cornea, Malformations of the. See **Congenital anomalies of the eye;** especially pp. 2804, 2829, Vol. IV, of this *Encyclopedia.*

Cornea, Marginal atrophy of the. The true nature of this disease has not been fully determined. The marginal layers of cornea become thinned and atrophied and, later, yielding to intraocular pressure, peripheral ectasia develops. The *senile marginal atrophy of Fuchs* is characterized by the formation of a gutter-like depression in the area of an arcus senilis, which later becomes ectatic as it succumbs to the intraocular tension. Fatty degeneration is responsible for the process in both gerontoxon and peripheral ectasia—the two conditions being anatomically similar.

Investigators have not been able definitely to decide whether the process is purely degenerative or one attended by inflammatory reaction.—(J. D. L.)

Angus Macnab has reviewed the paper of Gilbert (*Klin. Monatsbl. für Augenheilk.*, Aug., 1908) on this subject. The author discusses the relationship of the various non-ulcerative processes which occur in the marginal zone of the cornea in the light of some cases which he has observed for a considerable length of time. One of the cases is of great interest, as three stages of the same condition were found in different parts of the same cornea at the same time.

Gilbert's evidence shows that the clear marginal furrow which stretches and distorts the cornea is, in some cases at least, preceded by an infiltration resembling an arcus senilis. The same lesion may occur either on the central or on the peripheral side of an arcus already present. Position, therefore, is not a differentiating feature between Fuchs's "marginal atrophy" and Schmidt-Rimpler's "furrow-keratitis." Gilbert would identify these lesions, and describes three stages in their development: (1) "a superficial, greyish, corneal opacity, resembling a primary arcus;" (2) "a furrow with its base becoming

transparent;" (3) "a perfectly transparent furrow commencing to bulge."

Takayasu has shown that in a typical arcus the fatty degenerative process passes further into the cornea than is apparent clinically; and as in arcus senilis there appears to be a constant slight atrophy of the cornea peripheral to the opacity, Gilbert appears to be justified in his conclusion that these forms of marginal atrophy which he identifies are secondary to a change identical with, or similar to, arcus senilis.

J. H. Fisher, in discussing the paper of Van Duyse (*Arch. d'Opht.*, XXX, ii, November, 1910), remarks that Seefelder regards the marginal thinning of the cornea as the primary fault leading secondarily to the ectasia, and leaves it an open question whether the atrophy of the true corneal lamellæ is or is not preceded by inflammatory process. Van Duyse describes in detail a case in a man now seventy years of age in whom he had the opportunity of watching the conditions in each eye at intervals over a period of fifteen years. In the left eye of Van Duyse's patient the change was limited to an upper marginal segment of the cornea—in the right eye it involved the whole corneal circumference; ectasia of the central part of the cornea with diminution of its sensibility resulted; the tension was increased; cataractous change prevented any ophthalmoscopic examination of the fundus; some vesicular elevations of the epithelium were an unusual feature in this eye. Van Duyse agrees with Seefelder that the vascularization of the thinned corneal tissue is an attempt to repair the weakening tissue. Van Duyse thinks minor degrees of the conditions may be overlooked, and that, as in his opinion, it is met with chiefly in old patients who are the subject of arterio-sclerosis it should be excluded in cases presenting themselves for cataract extraction. A case recently reported by Fisher himself shows that it may be met with in early middle life: a portion of the attenuated corneal lunula, which was removed by operation in this case, has been pathologically examined by Coats. A feature of the specimen was great thickening of Descemet's membrane, which was regarded as an attempt to compensate for the thinning of the layers of the true cornea.

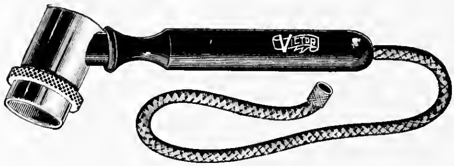
E. W. Brewerton (*Ophthalmic Review*, March, 1911) reported a case of a woman, æt. 70, with symmetrical marginal corneal degeneration. There was a history of defective vision from infancy "after vaccination." Vision had fallen in recent years. Each cornea had a yellowish, irregular band of opacity resembling wash-leather nearly completely encircling it, and the thickness was greater than normal. The condition was thought to be one of hyaline degeneration.

Finally, Zentmayer (*Annals of Ophthalmology*, Apr., 1912) has presented a case of marginal degeneration of the cornea. The patient was a married Italian woman, aged forty-five years, apparently in good health. She was first seen six weeks before, when she complained of headache and of an uncomfortable feeling in the eyes. In the cornea of each eye there was a groove about 2.5 mm. broad and about 0.5 mm. deep just inside of the limbus, and involving, approximately, the upper half of the circumference. In the right eye the groove was broader and deeper, and at the nasal end of the furrow the floor was slightly bulging (beginning ectasia). By diffuse light it appeared almost transparent, but by oblique illumination, gray. Fine blood-vessels encroached upon it from the conjunctiva. The eyes were entirely free from evidence of inflammation.

Cornea, Marginal inflammation of. See **Keratitis marginalis superficialis.**

Cornea, Marginal ulcer of the. This rare form of superficial ulceration of the cornea, described by zur Nedden, and said by him to be due to a specific organism, usually recovers under local disinfectants and the cautery, actual or chemical. Tincture of iodine or iodine-phenol makes an acceptable application.

Cornea, Mechanical massage of the. For this procedure a number of instruments have been devised. One of these is depicted in



Instrument for Massage of the Cornea.

the text herewith. The knurled collar is removable and is used to hold some suitable elastic material, such as rubber-dam stretched tensely across the opening. The instrument is attached to the ear pump, which pneumatically vibrates the rubber diaphragm, the vibrations being in turn communicated to the corneal surface.

Cornea, Melanosis of the. Blood-stain of the cornea. Corneal hemochromatosis. Pigmentation of the cornea. Discoloration of the cornea. This condition may be congenital or acquired. When an aberration of development it is characterized by pigmentation of the deepest layers of the middle portion of the cornea. It is usually symmetrical in both eyes. Kukenberg holds that the *congenital* form is often due to an abnormal development of the uveal tract.

In the *acquired* form, it may develop when the anterior chamber has been empty for a long time and the iris remains in contact with the cornea. The iridic pigment is then taken up by the cornea, upon whose posterior surface it has been deposited. There are, however, a number of other cases, as, for example, it has also been observed in hemorrhage between the corneal layers, in cases of irido-cyclitis, and following operations in the anterior chamber.—(J. D. L.)

According to Yamaguchi (*Annals of Ophthalm.,* July, 1904) *primary melanosis* of the cornea is very rare and, so far, has not been examined anatomically. He gives the microscopic description of two pig's eyes which exhibited an intense pigmentation of the central portions of the otherwise transparent corneæ. The pigment was exclusively localized in the epithelial layer, chiefly the basal cells, since, by the negative reaction to iron, the hematogenous origin of the pigment could be excluded. Yamaguchi assumes a metabolic formation of pigment from the albuminoid bodies of the cells. The corneal epithelia acquired exceptionally the specific faculty of the cells to produce and accumulate pigment which is congenitally inherent in the epithelia of the limbus.

Discoloration of the cornea was observed by Salus in a patient with multiple sclerosis. It assumed a ring form, and was thickest at the limbus. Other similar cases have been reported in patients suffering with multiple sclerosis, and Salus refers the condition to this cause. Senn comments upon the case, calling attention to the circumstance that the patient was a dyer; and refers to an article which he published in 1897 describing eighteen cases occurring in dyers using aniline colors, in whom the cornea was stained a sepia brown. A case of staining due to hemorrhage is reported by Kayser. See, also, **Blood-staining,** page 1226, Vol. II of this *Encyclopedia.* Oeller observed pigmentation of the posterior surface of the cornea near scars after operations. He thinks the pigment was derived from the iris, and believes its deposition is favored by the circumstance that the direction of the lymph-current is toward the wound until it heals. Conditions favoring attachment of pigment are obliteration of the anterior chamber, folding of Descemet's membrane, and loss of endothelium.

Wells reports a case of corneal staining with blood pigment following hemorrhage into the anterior chamber during sclerotomy for secondary glaucoma. The color was at first greenish, but at the end of a year had become gray. After three years the eye was enucleated. The histological examination showed pigmentation in the anterior fifth of the corneal stroma. Rounded bodies were observed somewhat larger than bacteria which stained with eosin and with Mallory

phospho-tungstic acid stain. The author agrees with Wadsworth and others that the material is probably hematoidin. Cantonnet saw a case of greenish staining in the cornea of a child following a blow. It was accompanied by increase of tension. The periphery of the cornea was clear as is usually the case. Sauvineau in discussing the case suggested that bleeding from the ciliary body may have pressed the root of the iris forward against the cornea and so prevented the imbibition of blood at this point. Jacub saw a case due to trauma.

The spectroscopic examination made by Gutman of a portion of a discoid opacity which developed in a cornea following hyphema gave negative results which seems to disprove the theory of Roemer that the staining is due to hematin. The possibility of globulin being a cause was excluded by digestion experiments. Von Michel exhibited a microscopic specimen in which there was marked pigmentation of the fixed corneal corpuscles as well as of the endothelium. Some small bodies present he considered to be hemosiderin. Laas reports a case following trauma, in which not only the peripheral zone was clear, but also a portion of the cornea covered by a pterygium, so that the resulting opacity was kidney-shaped. Fleischer has further investigated the three cases of spontaneous corneal hemosiderosis already reported, and concludes that the discoloration is a symptom of a general disease hitherto unrecognized, presenting a complex of symptoms partly resembling pseudosclerosis and partly *"diabète bronzé."* He regards the corneal staining as a hemochromatosis, a local manifestation of a general hemosiderosis. He also investigated cases of intracorneal hemorrhage after trauma. He found the granules of hemosiderin between the corneal lamellæ side by side with the well-known fine transparent granules which normally pervade the tissue and give no reaction for siderin. In a case of staining accompanying kerato-iritis and descemetitis in an adult after exposure to cold, the blood staining was in the lower part of the cornea. Posey, who reports the case, believes it to be due to saturation of the tissue with blood serum.

Among 106 self-inflicted injuries to the eye done to escape conscription, Wasiutinsky saw 44 cases of *artificial coloring of the cornea.* The stain was a yellowish-brown and was permanent. He experimented upon animals with a large number of chemicals and discovered that only silver nitrate and ochre left such spots. The former he believes is the agent usually employed. Higgins in a case of incised wound of the cornea instilled argyrol. A brown stain resulted which was still visible six months later. Marquez points out that the neutralizing of silver nitrate solutions with sodium chorid is liable to

cause a deposit of the latter salt. He has employed a 5 per cent. solution of sodium hyposulphite to remove such deposits and finds it extremely efficacious.

Holloway reports three additional instances. The pigmentation was always bilateral and fairly symmetric, seated in the deeper layers near the center of the cornea, and described as golden-brown to chocolate color. The area is generally oval or spindle-shaped, the long axis vertical, its size varying from 2.5 by 1 mm. to 4.5 by 3.5 mm.

Leslie Buchanan (*The Ophthalmoscope*, April, 1912) states that blood pigment of the cornea is due to recurrent hemorrhages in the anterior chamber. Baumgarten first described the condition in 1883, and Lawford a few years later conducted his investigations on the histologic findings. Twenty-five or thirty cases have been reported.

The importance of the condition is twofold. From the clinical point of view it is necessary to distinguish the appearances to which this form of pigmentation gives rise from those arising from dislocation of an amber-colored lens into the anterior chamber. From the point of view of prognosis it may be said that when the cornea presents this change in a marked degree there is probably a very serious alteration in the interior of the eye.

Five cases have come under Buchanan's immediate notice, two being seen only in the pathologic laboratory, the others having been watched clinically as well as examined histologically.

In all five cases there had been serious injury to the eye, such as a blow from a stone, a kick from a boot, a blow from a heavy stick, a puncture from a fork, and a blow from a hard rubber ball. In each case extensive recurrent hemorrhage into the anterior chamber had taken place, and owing to a long continued irritation of the eye, it was deemed advisable to remove the latter. The condition of the anterior of the globe, found on examination, varied somewhat, but in all it was clear that the correct treatment had been carried out, as it was hopeless to expect any good result to follow after such serious damage. Separation of the retina was found in three cases. Chronic cyclitis was present in the two others.

It may be accepted that the sequence of events is somewhat as follows: A quantity of blood having been liberated in the anterior chamber, clotting takes place and partial organization of the clot follows. The red corpuscles give up their hemoglobin, which is dissolved in the aqueous humor and carried through the spaces of Fontana into the cornea. In the central area of the cornea the currents are slower than elsewhere, and in some manner the hemoglobin becomes altered and a body is formed which is much less soluble and therefore

becomes deposited. This body may not be, and probably is not, always the same in chemical constitution. Thus E. T. Collins has shown that sometimes iron is not present, but that it is in a few cases. The chemical reactions are difficult to ascertain with exactitude, and spectroscopic examination does not give quite definite results, so that the precise nature of the substance which is deposited in the cornea is not clearly known, although in most instances it is probably hematoidin.

Buchanan reports a case, male, aged thirty-three, who was struck in the eye with a rubber ball. When first seen the eye was irritable, anterior chamber filled with blood, tension normal. After one month it was noticed that the central portion of the cornea was greenish in color. One month later tension + 1, blood increased in amount. After another month the cornea became greenish-amber in color, the blood filling one-third of the anterior chamber. Eye painful and tender. Eye enucleated. Sections of the cornea showed the pigmented area contained immense numbers of very small, highly refracting bodies, some elongated and some seemingly circular. It was seen that the granules varied widely in size, some being six or eight times larger than others. The granules stained poorly with any stain, but best with eosin. The largest granules were found in the anterior layers, the smallest in the central layers of the cornea. The elongated bodies were found scattered amongst the others, but in greater numbers in the anterior than in any other part of the cornea. Close examination showed that the pectinate ligament and the meshwork at the angle of the anterior chamber held a number of somewhat similar bodies. The posterior three or four lamellæ of the cornea were absolutely free from granules.

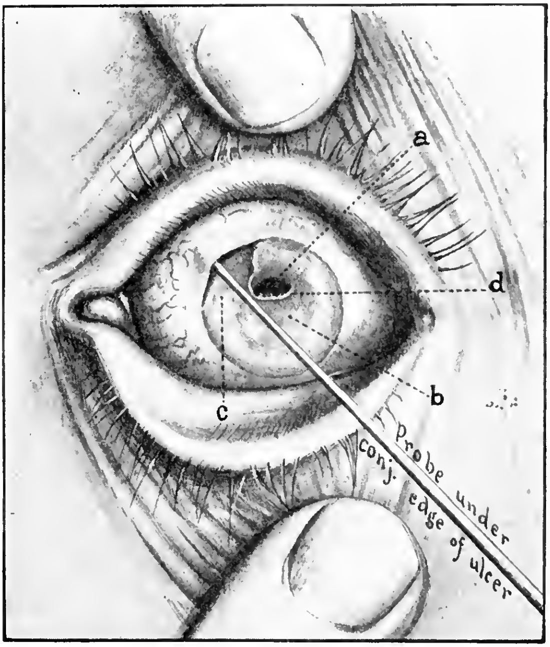
It is interesting to note that the spaces between the corneal lamellæ in and close to the area of cornea involved in the deposit contained a coagulated material, which had a somewhat gelatinous appearance, and which had not been described formerly.

The state of the iris is worthy of note in this case, there being a very distinct layer of newly formed fibrous tissue upon its anterior surface, passing completely across the pupillary area.

In connection with this subject it is of interest to note that Fleischer published a paper (*Münch. med. Wochenschrift*, 1909, p. 1120) which deals with "peripheral brownish-green corneal coloration." This peripheral coloration is found in certain general diseases, particularly cirrhosis of the liver, pancreatic disease, and certain forms of insular sclerosis of the brain and cord. Fleischer was of opinion that this pigmentation was hematochromic in origin. His-

tologic examination showed that the deposit was in the conjunctiva and in the membrane of Bowman, rather than in the corneal stroma. It is thus to be compared with the pigmentation of the skin in Addison's disease, rather than with that which is the subject of these notes. (Abstract in *Annals of Ophthalm.*, July, 1912.) See, also, under head of **Cornea, Blood-staining of the.**

Cornea, Mooren's ulcer of the. RODENT ULCER. ULCUS RODENS CORNEÆ. This disease is essentially chronic in nature. It always develops



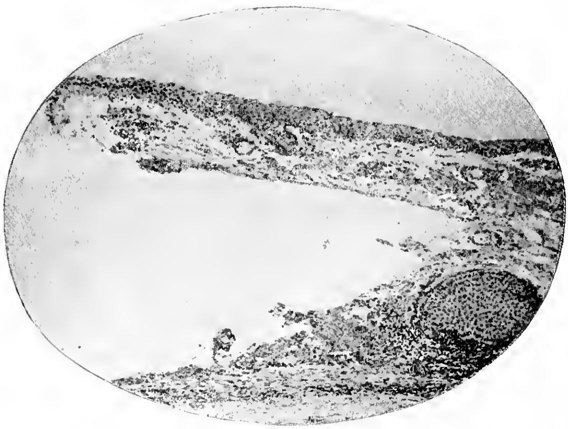
Rodent Ulcer of the Cornea.

a, The only part of the Cornea which has not been attacked but which is gradually becoming hazy with approach of the ulcer. *b*, Area of cicatrization after ulcer has run its course. *c*, Ulcerative process is especially marked in this area (note undermined limbus). *d*, Corneal or progressive edge of ulcer, showing crescentic shape which was more marked in early history of case. This edge is also undermined. (Randolph.)

primarily at the corneal margin—usually the upper—from which point it slowly spreads, with intervals of quiescence until, in some cases, the disease has invaded the entire cornea. The ulceration is of a grayish color, with edges which are characteristically undermined. As the slow-spreading necrosis never penetrates beneath the anterior half of the cornea—being usually limited to about one-third of the corneal

thickness—perforation very rarely results. The ulcerating process is accompanied by numerous vessels springing from the limbus. As fibrous tissue does not form at the site of the implicated area, and only one-half of the corneal structure being involved, the disease terminates without producing dense opacification or marked impairment of vision. It is, therefore, a less serious lesion than other forms of corneal ulceration, that penetrate deeper and, consequently, terminate with thicker scars. The absence of attempts at repair is an interesting and characteristic feature of this disease.

Rodent ulcer rarely occurs except in elderly people, which may be explained by the lower powers of resistance and diminution of the



Mooren's Ulcus Rodens. X 80. (Lister.)

The epithelium is very irregular in thickness, and extends round the tip; the sub-epithelial tissue is infiltrated and vascularised. The floor of the ulcer is covered with broken-down corneal tissue. On the right a round mass of epithelium is seen.

nourishment of the cornea, as suggested, for instance, by the appearance of arcus senilis. There is practically no discharge unless the process yields to the invasion of pyogenic organisms, an occurrence which, at times, transforms the ordinarily mild irritative symptoms into well marked inflammatory complications. The disease is frequently bi-lateral, and seems to be traceable to no causes except traumatism with simultaneous infection and defective nutrition. Asayama, in four cases, proved the presence of anchylostomiasis in three, but these conditions cannot be regarded as indispensable to the development of rodent ulcer.

Parsons, discussing the pathology, says:—"The granulation tissue which is seen forming the floor of the active ulcer is thicker and more

organized in the healed part. Here the total thickness of the cornea may exceed the normal. It is covered by much thickened epithelium, which has a very irregular base line, downgrowths often passing in various directions. Beneath this is the scar tissue, which is highly vascular and infiltrated with lymphocytes in the earlier stages, and consists of clear, fine fibrillæ in the older. This layer diminishes in

1 2

Mooren's Ulcer of the Cornea.

Fig. 1. Section through the widest part of the ulcer. X 45. Fig. 2. Lateral section of Fig. 1 (X50).

thickness from the limbus towards the ulcer. Beneath it are the corneal lamellæ. Descemet's membrane and the endothelium are normal."

The primary event seems to be the growth of the undermining granular tissue, followed, later, by necrosis of the superficial corneal layers.

With reference to the bacteriology of this ulcer, Collins says:—"Organisms have been found in the ulcer, but none have been identified as the cause of the disease and they are probably only saprophytic in nature." Parsons' views are similar. Hillemann believes it improbable that the ulcer is of bacterial origin from the fact that this disease distinguishes itself from similar ulcer formations by futility of therapeutics. However, Andrade's investigations lead him to believe that he has isolated a specific bacillus, whose characteristics are as follows—small, aërobic, rod-shaped Gram-positive organisms, lying side by side in groups or chains.

Treatment. For reasons yet undetermined, the arrest or cure of rodent ulcer is difficult. Aggressive treatment by cauterization is no longer popular with many former advocates. Covering the ulcerating area by bulbar conjunctiva, which may be preceded by curetting, is perhaps the most effective means of controlling this intractable disease.—(J. D. L.)

Hayashi found published reports of sixty-three cases of this disease; nine have now been anatomically studied, including the four reported by the author. He calls attention to its bilateral character, its greater frequency in men, and the larger percentage of cases to be met with in Japanese clinics. The microscopic examination showed the epithelium intact in the recent cases, but lacking or degenerated in the advanced cases, in which the corneal center becomes isolated by the advancing ring of ulceration. Bowman's membrane was seen to have great powers of resistance. It swelled up, or split, only in the immediate neighborhood of the ulcer.

He could find no evidence of infiltration or lifting of the epithelium, such as Schmidt-Rimpler describes. Such changes as the epithelium undergoes are due wholly to lack of nutrition, as the ulcer goes on advancing and shutting off the corneal center from the limbus. Epithelial hypertrophy occurs in the healing portion of the ulcer, especially at the margin of the excavation, where it heaps up and also forces itself in wedge-shaped masses deep into the corneal substance. Profuse hemorrhages are also recorded. Hyaline degeneration was not observed and no pseudo-pterygium was found. Anesthesia was not always present; there was no arcus senilis. The author's researches throw no light upon the etiology of the disease. Finding that the topical application of various caustics did no good, he resorted to operation. The progress of the disease was stopped in two cases, in one by slicing off what remained of the superficial corneal layers, in the other by grafting a conjunctival flap over the ulcer after it had

been seared with the Paquelin cautery. Two cases, however, resisted all measures, and the eyes were enucleated.

Hayashi gives a long list of caustics which he tried unsuccessfully. Nitric acid is not on the list. Its value is attested by Stevens and Jackson. Stevens reports a case of non-purulent ulcer in a woman of seventy-two years. Situated at the upper margin, it was crescentic in shape, with the edges undermined for 2 mm. The advancing border was of a dull-white color. The ulcer was anesthetic. At first there was little redness, but later a pericorneal injection appeared. Curetting did no good, nor did cauterization with iodine or carbolic acid. It finally got well after repeated cauterizations with nitric acid, having lasted in all fourteen weeks. Jackson describes a Mooren ulcer which occupied the lower two-thirds of the cornea, in a man of sixty-four years. It was vascularized at the temporal side. One-fourth of the cornea at the nasal side stained with fluorescein. He cauterized the ulcer with nitric acid five times in eighteen days. After cauterizing there was pain for six hours. The ulcer finally healed.

Randolph calls attention to the undermining of the conjunctival as well as the corneal boundary of the ulcer. Early recognition of the disease is impossible, chronicity being an important element in the diagnosis. He tried phenol, trichloracetic acid, iodin and the galvano-cautery without avail, a low grade of iritis developed and eventually the eye was enucleated for pain and redness. A case unsuccessfully treated is reported by Weigelin. Among other remedies scarlet red was tried. The other eye had been lost twenty-four years before with the same disease. Jones reports the cure of two cases by the use of zinc iontophoresis.

In two cases reported by de Schweinitz a variety of treatment failed to check the progress of the ulcers, and the eyes were enucleated. The corneal epithelium was found irregularly thickened; and in front of the pupil had become invaginated beneath a mass of lamellated connective tissue elements. Adjoining the affected area there was dense infiltration of the cornea and sclera by large, round, connective tissue cells. The deeper portions of the eye were normal. The only application which appeared to do good was the mild caustic of Ewing.

In a case reported by Gallemaerts the edges of the ulcer were excised with a Graefe knife, and a flap of conjunctiva drawn over the denuded surface. This arrested the process. In a case reported by Rubert the ulceration was checked by cauterization. (Abstracts from the *Ophthalmic Year-Book;* see particularly p. 85, 1904.)

Cornea, Mushroom opacity of the. A case of this very rare lesion is reported by P. C. Bardsley (*Ophthal. Review*, Feb., 1908). George

A., aged fifty-three, had suffered from diminution of sight in the right eye for three months. The family history is negative, but there is evidence of early disseminated sclerosis. On the right cornea, situated down and in, near the periphery, is a superficial opacity, surmounted by a fringed cap consisting of several linear markings placed close together with comparatively clear spaces between. The whole area represents a "mushroom-shaped" opacity of the cornea, which is beginning to show some signs of degeneration.

Cornea, Myxoma of the. See **Cornea, Polypoid growths of the.**

Cornea, Necrosis of the. Keratomalacia. See **Keratitis, Xerotic.**

Cornea, Neoplasms of the. Tumors of the cornea will be found under the caption proper to each, as well as under the major heading, **Tumors of the eye.**

Cornea, Neuralgic herpes of the. According to Cabannes, there are three varieties of this disease:—(1) Herpes corneæ febrilis, (2) herpes neuralgica, (3) zona ophthalmica. Neuralgic herpes is very rare. It was observed by Graefe four times in 5,000 cases. This variety is preceded by violent pain for twenty-four hours before the eruption appears. The pain ceases with the advent of the eruption. The vesicles heal in from two to four days. Cabannes reports a case of this variety. The man first noticed a heaviness about the eye. Early the following morning he awoke with intense neuralgia in the opththalmic region. The lids were red and edematous. There were blepharospasm, photophobia, lachrymation and conjunctival injection. On that day the cornea showed absolutely no lesion, but was hyperesthetic. Atropine was instilled and the pain ceased. The next day there appeared upon the cornea three white superficial spots with a mother-of-pearl lustre, and simulating foreign bodies. These were the ruptured vesicles from which the serum had escaped, leaving the epithelial covering. The superficial seat of the lesions is especially to be noted. In this respect neuralgic herpes differs from ophthalmic zoster, which affects the deeper structures of the cornea. It differs also from febrile herpes, for most cases of this affection develop corneal ulcerations, which are slow to heal.

Cornea, New vessels in the. See **Cornea, Vascularization of the.**

Cornea, Nodular opacity of the. Nodular keratitis. Groenouw's disease of the cornea. Family degeneration of the cornea. This rare corneal affection, which has characteristics similar to those of punctate keratitis, manifests itself in the formation of numerous small corneal opacities, the largest of which usually occupy the central portion. When examined with the loupe, the opacities are seen to be composed of numerous minute rounded or irregularly-formed, grayish

spots, located in the superficial layers of the cornea. In some cases rather large irregular patches appear at the pupillary area, which result from a coalescence of the small opacities. Between the opacities the cornea appears dull and hazy, and over the affected site the epithelial layer is somewhat elevated. The peripheral portion of the cornea is generally uninvolved. Nodular opacities usually appear simultaneously in both eyes and frequently *several members of the same family are afflicted.* It is a disease occurring early in life, slow, chronic and increasing in its course, unaccompanied by true inflammation, and without any basal disease influencing its origin.

Disturbance of vision is commensurate with the extent and location of involvement and density of the opacities.

Collins and Mayou state that hyaline material has been found in the patches. Fuchs reports a case in which he removed a piece of the affected area by the trephine and found microscopically an amorphous substance between the fibrous lamellæ.

The cause of nodular opacity of the cornea is obscure and no effective treatment has been discovered.—(J. D. L.)

Geo. B. Jobson (*Ophthal. Record,* July, 1912) recommends (and has published a successful case of) removal of the opacity by means of keratotomy.

Dunbar Roy (*Archives of Ophthalm.,* Sept., 1912) reports this rare lesion in a mother and five children. The clinical symptoms were most marked in the mother and differed in degree, according to the age of the patient, being hardly perceptible in the youngest child. The author refers to the diversity of nomenclature under which such cases have been described and believes they could all be designated as "family degeneration of the cornea," as described by Fehr and Fleischer. In the author's cases there was an absence of all inflammatory signs, and tuberculous tests were negative.

Paderstein (*Klin. Monatsbl. für Augenheilk.,* Feb., 1909) has described a case where he had the opportunity of examining the whole eye, which was removed after death.

The patient, a blacksmith, aged forty-one, came under Paderstein's observation on account of an injury to the right brow which led to periostitis, and ultimately to suppurative meningitis; but this appears to have had no relation to the condition of the cornea, as the nodular opacities had been noted two years before. There was no history of any other members of the family being similarly affected, and syphilis, rheumatism and tubercle could be excluded.

The primary seat of the disease, as shown by the sections, is in the basal cells of the epithelium. These changes cannot be considered as

secondary, i. e., due to pressure by the nodules, as changes are found in the nuclei far from the embedded substance.

Paderstein considers that a degeneration of the epithelial cells, of which so far nothing is known, takes place, in the progress of which the nuclei are destroyed and the protoplasm changed to a hyaloid substance, the real nature of which is not definable, although it is to be distinguished from the known products of degeneration (amyloid, etc.), as it does not give their reactions. This degenerative process is not confined to the basal cells, but affects the adjoining layers also; by fusion of the degenerated cells knots and little heaps are formed.

He explains the presence of cells and remains of cells found in the spaces between the layers of the stratification as being due to the partially degenerated cells being separated from those which have become completely degenerated; the hyaloid substance is more inclined to adhere to Bowman's membrane, and to the normal epithelium, whilst those cells in the process of change seem to be agglutinated with the substance. Besides these processes of degeneration, which are of chief importance, processes of secretion may have an influence, the presence of a kind of membrane on the basal cells indicating this. Though inflammatory symptoms are not altogether absent (i. e., the existence of small vessels on the surface, beneath the epithelium on the upper limbus, and sporadic infiltration on the back of Bowman's membrane), they are too insignificant to claim notice.

Paderstein compares his own observations with those of other authorities. Thus, hyaloid deposits were found by Groenouw, Fuchs, Sattler, and Dimmer, but Groenouw and Fuchs found them in the parenchyma of the cornea. Fuchs found Bowman's membrane defective, and he considered the slight change in the epithelium of the cornea as secondary. Sattler found the hyaloid deposit in the upper layers of the lamellæ, Bowman's membrane being for the greater part missing. Wehrli differs from them all, as he considers the condition to be of a tubercular nature.

Paderstein quotes a similar case reported by Elschnig, where the whole cornea was examined, and which he describes as a case of "druse-formation" on Bowman's membrane, but he did not find degeneration of the base cells, and he therefore calls the nodules "liberation products of the epithelium." His case differs from Paderstein's in the evenness of the surface of the cornea, and in the appearance of the opacities, which were iridescent.

Elschnig contends that the formation of "drusen" on Bowman's membrane differs from that of other hyaloid membranes, as with the latter it is at the outset epithelial, whilst Bowman's membrane owes

its existence to a process of concentration of the frontal lamellæ of the cornea, and is therefore of a mesodermal origin. The differences observed by the various authorities may be explained as due to different phases of the same process.

Paderstein's observations seem to support Fleischer's theory, that in all these cases of nodular opacity of the cornea, a deposit of "foreign substance" has occurred. (H. H. Folker in the *Oph. Review,* June, 1909.)

A composite picture of the disease, says Zentmayer (*Ophthalmology,* July, 1909), made from cases subsequently reported by other observers would be as follows: A number of small opaque patches of all shapes occupy the most central portion of the cornea, while between and sometimes reaching out to the periphery, but oftener leaving a clear margin, are innumerable very fine dots. The patches are grayish and beneath the epithelium, which is at first not altered. Later the patches become elevated. Commonly there is no irritation. The disease is intractable and in the course of time the opacities become denser, the anterior ciliary vessels become distended and vision sinks greatly. There may be slight pain with lachrymation and swelling of the lids. It occurs more frequently in young adult males, and often attacks one or more members of a family and occurs in one or more generations. The only similar case in American literature is that of Veasey, who classed his with that of Fehr's "Family macular degeneration of the cornea," a supposed intermediate form between "nodular" and "lattice-like" opacities of the cornea.

The nodule is composed of layers of fibers in a more or less advanced stage of hyaline change, in some places quite homogeneous; in others (the minority), lines of demarcation can be made out. This represents the gradual melting of the fibers, which is apparently a regressive metamorphosis. On one surface of the section Bowman's membrane is marked and has been separated into fibers much more distinct than the underlying fibers of the parenchyma; on the other side of the section the membrane melts into the substance, becoming a part of it where it turns to fold upon itself. There are no cells between Bowman's membrane and the substantia propria that have been described by other writers, the continuity being quite complete on both surfaces without any intervening space. The hyaline matter may be described as lamellar in character in contradistinction to fibrillar and lancellate, and this forms only because the type of tissue undergoing the change is of this structure.

For the reasons given, the lamellæ are not separated by fissures and the cells present are a part of the fixed elements. Inflammatory

phenomena are entirely wanting, nor is there any blood-vessel formation. The change appears to be a slow degenerative process resulting in complete confluence of all fixed elements, including the products of cell destruction.

Folker (*Practical Medicine Series,* p. 73, 1910) reports nodular opacities of the cornea in nine patients of twenty-five members of one family running through three generations. Of the first and second generations five were examined, and nodular opacity was present in three members. In these cases, in addition to the opacities, fine lattice-like lines were found in conjunction with them. This latter condition was absent in members of the third generation. The nodular opacities were fewer in number and less in density in the younger members. In all the cases they appeared to be situated in the anterior layers of the substantia propria, the epithelial layer not being involved. No signs of syphilis or history of rheumatism were present in any of the cases.

Finally, an abstract of the treatise by Elena Puscarin (*Arch. d'Ophtal.,* Vol. 33, June, 1913) is given in the *Ophthalmic Review* for December, 1913.

Puscarin gives clinical reports of two cases of this rare affection. The first was a man of twenty, in whose case the corneal affection had been noticed for three months before he was first seen, as causing a diminution of vision, first in the right eye and later in the left. There had never been any inflammatory symptoms, but the patient had himself observed the opacities in the cornea. This patient's cornea showed at the center white spots, the size of a pin's head, arranged in a square. Between these were numerous smaller spots, diminishing still more in size farther from the center, so that at the periphery they could only be recognized with a loupe. Wassermann reaction was negative, but 1 mgr. of tuberculin caused fever, headache and nausea. He was treated with 20 injections of tuberculin without the slightest effect on the cornea. When seen again, a year and a half later, the condition was unchanged.

The second case was also a man, but considerably older, forty-five years. He had suffered from hemoptysis and had been a heavy drinker. In his case the affection had begun six years previously with lachrymation, photophobia and pain. When seen by the author the pupillary area of cornea in both eyes was occupied by whitish irregular blotches, not exceeding ¼ mm. in diameter. The epithelium over the patches was prominent. On examination with the loupe the whole interstitial tissue of the cornea appeared infiltrated with minute gray points. The Wassermann reaction as also that to tuberculin

were negative. There were, however, physical signs of healed pulmonary tuberculosis. No treatment had any effect.

A small superficial piece of corneal tissue was removed with the trephine and submitted to microscopic examination. This showed that the nodular opacities were due to a degenerative process of the tissue of the cornea, consisting, first, of a distension of the cells and the accumulation in their protoplasm of abundant granules probably colloidal; second, alteration of the corneal lamellæ, which lead to their dissociation and destruction. As a result of these deep alterations the epithelial layer suffers in its nutrition and undergoes a process of atrophy. In none of the preparations was there the least trace of any inflammatory reaction, either of the corneal tissue or of the epithelium.

Consequently, Puscarin, in spite of the fact that both patients had signs of tuberculosis, is unable to agree with Wehrli's theory that the nodules are a tuberculous process. Puscarin prefers to agree with Fuchs in attributing the lesions to the manifestation of some obscure trophic affection of the proper tissue of the cornea. See, also, **Cornea, Lattice-shaped opacity of the.**

Cornea, Nutrition of the. As Baker (*System of Diseases of the Eye*, Vol. I, p. 156) remarks, notwithstanding the absence of blood-vessels the nutrition of the cornea is very active, as is shown by the rapidity with which wounds are repaired, a day sometimes sufficing for healing when the conditions are favorable. This is probably due to the extraordinary copiousness of the lymph-supply, which here takes the place of blood. In wounds involving loss of substance, the epithelium is renewed by proliferation from that surrounding the wound, but the tissue of the cornea proper is replaced by cicatricial tissue which never becomes perfectly transparent. The anterior membrane is never renewed.

Hamburger believes that the cornea participates in the absorption of the aqueous, and has made several experiments in order to prove his contention, by injecting methylene-blue *intra vitam*. 1. Injection of sodium-indigo-sulphate into the anterior chamber stains the corneal cells; shrinkage is prevented by injecting alcohol from the heart. 2. By injecting 40 c.c. to 50 c.c. of a 2 per cent. solution into the femoral vein of a large rabbit, weighing 3 kg., the corneal endothelium and that of the ciliary body were stained. 3. The most convincing but most delicate of all is injecting 1.5 c.c. of a 2 per cent. solution into the auricular vein of a rabbit, when only the cells of Descemet's membrane will be stained blue.

On the other hand, Schnaudigel finds, after intravenous injection

of trypan blue in the rabbit, that amongst other tissues the cornea is stained slightly, the sclera deeply. In the cornea alone the typical pyrrol cells are missing. He does not mention the staining of the endothelial cells on Descemet's membrane, and finds the corneal corpuscles stained only slightly at the limbus.

Cornea opaca. (L.) An ancient name for the sclera.

Cornea, Opacities of the. CORNEAL OPACITIES IN GENERAL. SCARS OF THE CORNEA. CICATRICES OF THE CORNEA. Every inflammatory condition of the cornea (keratitis), suppurative or non-suppurative, is accompanied by more or less opacity of the cornea, usually induced by tissue changes. The extent and duration of the opacification largely influence its permanency. In this section, mostly those opacities which are stationary will be considered.

Opacities result from two causes, first, inflammation, and, second, traumatisms. They are named from their appearance as regards density (depth) and the extent of the corneal involvement, as follows: *nebula*, a faint, translucent, superficial opacity, rather bluish-white in appearance, often visible only by oblique illumination; *macula*, a small grayish or pure white, dense opacity easily discerned by daylight; and *leucoma*, a dense, large and therefore disfiguring opacity, which, when there is inclusion of the iris, is called *adherent leucoma*.

Opacities of the cornea are important, as they are so frequently a cause of impairment, or loss, of vision. If Bowman's membrane (anterior limiting membrane) or the deeper structures of the cornea have been injured, there remains, as a result, a permanent corneal opacity; in other words, the epithelial layer is the only part of the cornea which is replaced without change of structure or loss of transparency. However, there are stationary opacities limited to the epithelial layer resulting from constant and prolonged mechanical irritation, examples of which are sometimes observed in cases of pannus and trichiasis. An opacity of the cornea becomes permanent when new-formed connective tissue and the vessels that extend into it remain between the corneal lamellæ. In other words, when connective tissue forms in place of normal corneal tissue, a *scar* is the result. Dense opacities vary in color from grayish-white to pure white with pretty well defined outlines. They usually correspond to the contour of the normal cornea. Sometimes the reconstructive process has been incomplete and a permanent depression remains, constituting a *facet* of the cornea. In other cases the scar is situated above the adjacent normal corneal tissue (*ectasis*). Flattening of the entire cornea, *applanatio cornea*, results from retraction of the cicatricial tissue sub-

sequent to extensive perforation of the cornea. In rare instances the cornea becomes flattened in severe cases of non-purulent keratitis, especially when iridocyclitis has coexisted. The exudates in the latter disease tend to the deposition of fibrin, with the formation of extensive membranous, connective tissue, the contraction of which favors corneal flattening by reducing the intraocular tension.

It is important to determine whether any part of the iris is included in old corneal scars, for such implication, especially if the cicatrix be ectactic, renders the eye, even from a mere abrasion of the epithelial covering, vulnerable to microbic infection and ulceration. This, in turn, may be followed by a panophthalmitis from an infection which has invaded, by continuity, the tissues of the uveal tract.

The visual impairment attending the presence of corneal opacities depends upon their size, density, situation with reference to the pupil, and to the amount of distortion of the cornea induced by contraction of its surface. Amongst the refractive errors dependent upon corneal scar-formation are hyperopia, myopia, irregular astigmatism, accompanying which may be strabismus, nystagmus or polyopia.

With reference to the increase of tension induced by incarceration of the iris in corneal scars, Fuchs gives the following rules:

Scars without incarceration of the iris.	Flat.	No increase of tension.
	Ectatic (keratectasia).	Increase of tension frequent.
Scars with incarceration of the iris.	Flat.	Pupillary margin partly free; no increase of tension.
		Pupillary margin totally incarcerated; increase of tension always occurs.
		Ectatic staphyloma; increase of tension always occurs.

With regard to the origin of corneal opacities, Fuchs believes that, "From the form and position of corneal opacities we may often gather an impression as to the variety of keratitis to which they owe their origin. Thus: (a) Maculæ of the cornea originate from small corneal ulcers. They most frequently develop in childhood as a consequence of conjunctivitis eczematosa, and in that case are often distinguished by being situated on the margin of the cornea. Quite characteristic opacities are the elongated ones that are left by a vascular fasciculus. These after they have lasted a long time clear up in the portion that adjoins the margin of the cornea. (b) Opacities which are faint and diffused, but which are nevertheless spread over the greater part of the cornea, are mostly the result of pannus or of

parenchymatous keratitis. Opacities resulting from pannus are situated superficially, while those due to parenchymatous keratitis are situated in the depth of the cornea, and when examined with the magnifying glass disclose, even years after the inflammation has ceased, the presence of deep-seated vessels (Hirschberg). (c) Extensive, tendinous-looking opacities, without incarceration of the iris, in which chalky-white dots are often visible, are observed after particularly severe cases of parenchymatous keratitis. Similar white dots also occur sometimes in the opacities due to pannus; also in those resulting from corrosion by lime, in this case depending upon imbedded calcareous particles. Finally, scars with incrustation of lead are also distinguished by a sharply circumscribed, extremely white opacity. (d) Marginal, crescentic, or arcuate opacities are the consequence of catarrhal ulcers or of keratitis marginalis profunda; they should not be confounded with an arcus senilis. (e) Marginal scars with incarceration of the iris form after perforating ulcers in conjunctivitis eczematosa. They are round, often consisting of a thinner, dark center (the incarcerated iris) surrounded by a white cicatricial ring. They lie so far peripherally as often to extend into the limbus, and on account of this peripheral situation are associated with a particularly marked displacement of the pupil. (f) Large, dense scars with inclusion of the iris, which often occupy the whole cornea except a narrow rim about the margin, are most frequently produced by an ulcus serpens or by gonorrheal conjunctivitis. The same sort of extensive cicatrices also occur after keratomalacia, diphtheria, and burns; in the last two cases scars upon the conjunctiva are never wanting, and conduce to the correct diagnosis. (g) Sharply defined punctate or striate scars are the result of traumatism, whether effected by accident or by design (operation). (h) Dense, white scars, which occupy the lowermost part of the cornea and terminate above in an almost horizontal border, are caused by keratitis e lagophthalmo. Sometimes we see men in whom such scars are present in both eyes. In this case the scars are usually the consequence of some severe disease, in which a condition of somnolence and a resulting imperfect closure of the lids were present and lasted for some time. (i) Opacities in the lowermost part of the cornea having the shape of a triangle with its apex directed upward are the result of a parenchymatous keratitis which, contrary to rule, has become localized in the lower half of the cornea, or they are due to the deposition of an exudate upon the posterior corneal surface. (j) Small, bluish-white opacities which are situated at the margin of the cornea and project into the transparent part of

it under the form of obtuse-angled triangles, are the residua of a sclerosing keratitis."

The means employed in the *treatment* of opacities of the cornea are intended to decrease the opacification, to improve vision, and to mitigate the attending discomfort and disfigurement, but the results, at best, are quite disappointing. The means employed are: (a) optical; (b) mechanotherapy; (c) medicinal; (d) surgical.

(a) The *optical aids* consist in the proper correction of refractive errors by suitable lenses. It is sometimes possible to bring about considerable improvement in vision by careful, painstaking optical corrections when any part of the visual impairment is due to a change in the corneal curvature. Stenopaic apertures will improve vision, in some cases, by lessening the dazzling produced by diffusion and by directing the light rays through the transparent portion of the cornea.

(b) Treatment by mechanotherapy consists of some form of corneal massage combined with a medicinal agent. Rotary friction-massage (see **Cornea, Mechanical massage of the**) may be applied directly by a spatula, lens spoon, special masseur or indirectly through the closed lids. Corneal massage is productive of the best results when used in connection with mercurial ointment placed within the conjunctival sac when the indirect method is used, or upon the spoon or spatula when we elect to employ direct massage. Of the mercurial ointments, the one most in favor is the yellow oxide, 10 per cent strength. See, also, **Brown ointment.** This old method is sometimes productive of noticeable results. In referring to the use of electricity, Fuchs says that it has given him good service in some cases. The positive pole of a constant-current battery is placed on the temple or the neck, while the negative pole is applied to the previously cocainized cornea. The negative pole consists of a solid cylinder of silver, 7 mm. in diameter. This is surrounded by an insulating envelope of caoutchouc, the only portion exposed being the surface at its end, which is concave so as to fit the surface of the cornea. Contact between the electrode and the cornea is effected by a drop of mercury, which readily adheres to the concave surface of the silver. The current intensity employed is 0.2 to 0.5 milliampères.

(c) Calomel (mixed with equal parts of sugar of milk) dusted on the cornea once or twice a week is an old and still moderately popular means of rendering corneal scars less opaque. Powdered dionin, however, is regarded as a more potential remedy. Among other medicamentous agents employed to induce irritation, stimulation and acceleration of absorption, are peronin, gallicin and jequiritol, all of which

undoubtedly exert more or less influence upon the clarification of corneal opacifications.

Pick observed marked clearing of old chalky opacities of the cornea by the use of aqua ammonia, one to three teaspoonfuls added to a glass of lukewarm water and applied as compresses for twenty minutes three or four times daily. The treatment should be continued for several weeks.

Suker recommends thiosinamin, one to three-grain doses two or three times daily, to be continued for weeks or months. This remedy is said in certain cases to produce a varying amount of absorption.

Moist heat alone, or used as an adjunct to the several local measures above mentioned, is of unquestionable efficacy.

The success of whatever means selected to promote absorption of corneal opacities is largely influenced by the age of the individual affected; the younger the subject the more pronounced will be the response.

(d) Scraping off the scar tissue, in the hope that the new cicatrix will be more transparent than that which it replaces, has been recommended by some authorities.

Optical iridectomy and tattooing of the cornea are described under their proper headings, and should not be forgotten as of considerable value in certain cases.—(J. D. L.)

G. B. Jobson (*Ophthalmic Record*, July, 1912), working along the lines pointed out by Wiener, has operated on fifteen cases of corneal scars and opacities by keratotomy for the removal of opaque tissue, and finds the results warrant recommending the operation as worthy of consideration in many cases. The instruments used include the keratomes, fixation forceps and a small tenaculum.

The eyeball is steadied with the tips of thumb and fore-finger placed on each side of the cornea, and a perpendicular cut made with the keratome to the appropriate depth, around the scar. Success depends upon the removal of the abnormal tissue in layers, until clear cornea is encountered. If this is done correctly the surface left will be comparatively smooth, clear and parallel to the uncut corneal surface. Care must be taken that Descemet's membrane is not punctured. The eye is flushed with normal salt solution, or one of boric acid, or an alkaline wash. The lids are closed and fixed with a thin layer of cotton wet with boric acid solution, and covered with gauze attached by adhesive strips. The eye should be dressed daily. Cases of nodular keratitis and symblepharon following corneal ulcer are reported improved in appearance, but without much increase of vision.

The results obtained by D. Bruno by the use of fibrolysin in eye

diseases are worthy of note. It acts beneficially in softening scar tissue in leucomata after the subsidence of keratitis with hypopyon. Well-marked leucomata, which seriously interfered with vision, he reduced to slight nebulæ by injections of fibrolysin into the glutei, or into the back. These injections were found to be equally efficacious in cicatricial spots resulting from syphilitic iritis, and exudative choroiditis. In many cases they were useful in softening and loosening the scar tissue, and thus facilitating further treatment.

Galezowski (*Recueil d'Ophtalmologie*, June, 1908) has used thiosinamine in solutions of 5 per cent. to 15 per cent. for corneal nebulæ with very satisfactory results. These solutions are used in an eyebath and are well borne as a rule. Should they give rise to a little redness of the eye, after a few days' application, they must be discontinued for some days, and if their application causes pain a few drops of cocain may be instilled beforehand. The baths are used once or twice a day for about five minutes at a time. In the case of children the same solutions are used in the form of drops. Galezowski's results in 26 cases were as follows: 9, very marked improvement; 11, appreciable improvement; 6, no change. In the course of some weeks the leucoma can be seen to be less white and less visible, and although it does not disappear altogether, it soon allows of the easier transmission of light.

Windmüller (*Medizinische Klinik.*, March 1, 1908), having failed to influence an opacity of the cornea by intramuscular injections of fibrolysin, tried the local application of this product. He has employed fibrolysin in this way in the treatment of various affections of the eye. The best results have been obtained in corneal opacities, whether of inflammatory or non-inflammatory origin. The remedy should not be used until all active signs have disappeared. The fibrolysin is applied one to three times a day, the absorbent powers of the eye having been reinforced by the application of dionin (2 to 10 per cent., gradually increased).

Slight stinging pain is the immediate result of the application, but rapid winking speedily removes any discomfort. Fibrolysin, in Windmüller's experience, causes a disappearance or a reduction of the corneal opacity, and in some cases, an improvement in sight. The æsthetic gain is sometimes very marked. The fibrolysin should always be used fresh.

J. A. Andrews employs iodine-vasogen (q. v.) in 5 to 10 per cent. solution, making the application on a cotton-tipped probe, every other day until the infiltration shows signs of shrinking; then, according to indications it may be applied every third day. Sometimes this

remedy causes decided pain even in milder solutions. For this reason Andrews prepares the eye by washing it with a normal salt solution, afterwards instilling a 2 per cent. solution of alypin. Before applying the iodine-vasogen, the excess of tears should be carefully wiped from the eye with cotton.

Homer E. Smith has had brilliant results, even in corneal leucomata, from the use of dionin with atropin, but he also employs as an adjunct, hypodermically, 15 to 30 minims every other day of the following: Thiosinamin, antipyrin, āā gr. xv; aquæ dest., fl. ʒi.

Turpentine is also employed in local applications to the eye as a stimulant to absorption of corneal opacities. Königstein dilutes it one-half with almond oil for this purpose. A single drop is instilled into the eye which is then covered by a protective and the ensuing hyperemia watched. Undue irritation should be avoided, especially as the treatment may have to be continued for several weeks.

J. M. Woodson has had excellent results in the treatment of corneal opacities from the local use of dionin in the form of powder. He has noticed that the improvement continues as long as the drug produces irritation of the cornea and conjunctiva.

Guillery and zur Nedden (*Archives of Ophthalmology*, Sept., 1907) advise the employment of 5 to 10 per cent. solutions of ammonium bitartrate, neutralized by the addition of liquor ammoniæ, in removing opacities of the cornea produced by lime burns. The solution is applied in an eye-cup three times daily. A little cocaine may be used in conjunction with the treatment, although the pain is not severe. To be effective the treatment must be applied early before the deposits take on the form of the carbonate.

Sulzer (*Annales d'oculistique*, Nov., 1906) discusses the effect produced upon opacities of the cornea by electrolysis, phototherapy, and radiotherapy.

Electrolysis. "After the eye has been cleansed, and rendered anesthetic by cocaine, the lids are separated by means of a speculum. The negative electrode consists of a bit of silver wire, 1.5 mm. in diameter, the end of which has been fused in a Bunsen flame, so that it forms a smaller or larger bead. The positive electrode, which is applied to the nape of the neck, is formed by a zinc plaque, enveloped in moistened wash-leather. When the silver electrode is applied to the cornea, a fine foam forms, and by a longer exposure, the nebula is raised by small bubbles, 0.3 mm. or so in diameter, which are produced between the cornea proper and the opacity. The electrodes are in communication with a table containing the resistances and measuring instruments, supplied by accumulators giving a current of 110 volts.

During the application the voltometer should register four to six volts. According to Sulzer, the results obtained from the electrolysis of nebulæ are good. The improvement of vision, however, is not so pronounced. At the same time, acuities below 1-10 may be raised to 2-10 or 3-10, while acuities of 0.2 to 0.4 have been improved 1-10 or 2-10. Six cases are quoted by the author in support of his conclusions.

Phototherapy. The source of light is the arc lamp of Broca-Chatain, which is rich in characteristic radiations. A quartz lens, having a diameter of 40 mm. and a principal focal distance of 50 mm., is placed at a distance of 100 mm. from the lamp, and provided with a diaphragm. The eye is placed at the conjugate focus of the arc formed by the quartz lens. In order to diminish the intensity of light as much as possible, the pupil is contracted by means of physostigmine or pilocarpine. Cocaine is also applied to the eye, the lids of which, if necessary, are held apart by an assistant or by a speculum. The time of exposure is from 20 to 90 seconds. The minimum exposure must first be adopted, but when the reactional susceptibility of the patient has been determined, the duration of the sittings may be prolonged. Successive exposures are made at intervals of from one week to two weeks. Their number varies from four to twenty in individual cases. Sulzer is of opinion that short exposures at comparatively short intervals are preferable to longer exposures given less frequently. After exposure to actinic rays, reaction occurs, which is proportional to the length of exposure. This appears at a time that varies from two hours to two days after the treatment, and manifests itself by redness of the eye, lachrymation, and lancinating pains. On examining the eye during this phase with focal illumination, one observes a slight and uniform dullness of the cornea, together with ciliary redness, but these appearances vanish in the course of a few hours or of three days at the most. Employed after electrolysis in superficial and clearly-defined nebulæ, or by itself in cases of sclerosis, phototherapy may cause a considerable improvement in sight. Sulzer makes the important observation that under the influence of the light treatment, tension falls, pupillary exudations become absorbed rapidly, and that posterior synechiæ undergo rupture. Nineteen cases are quoted in support of the author's conclusions.

Radiotherapy. No particular reaction followed the exposure of sclerosed corneæ for a period of eight minutes to the rays emitted from the anticathode of a radiogenic tube, which gave out ½ H. per minute. The same exposure, however, produced a violent and salutary reaction in a case of trachoma. During the two or three weeks follow-

ing the application of the X-rays a slow but sensible clearing was observed in the sclerotic corneæ. Radiotherapy, according to Sulzer, produces curative effects analogous to those obtained by the light treatment, although they are more feeble and slower. On the other hand, they have the advantage of being associated with neither reaction nor pain.

From his experiments Sulzer concludes that physical agencies are able to improve the sight of those affected with opacities of the cornea. The best application for this purpose is electrolysis combined with phototherapy for corneal opacities, or phototherapy alone for sclerosis, such as follows interstitial keratitis. In timid subjects, phototherapy may be replaced by radiotherapy." (Wood's *System of Ophthalmic Therapeutics*, p. 731.)

For the removal of corneal scars Arlt (*Medicinische Blätter,* Jan. 12, 1907) applies 0.005 gm. of dionin once a week, combined with light massage of the cornea. After several weeks the patient can use the drug himself in the same dose as a solution or ointment. From cases he has treated the writer concludes that dionin can be applied for several months in one-drop doses of a 10 per cent. solution weekly, without diminishing the efficacy of the drug. Superficial maculæ corneæ, especially those remaining after conjunctivitis lymphatica, clear up, even after they have lasted for several years.

Martin H. Fischer (*Pflüger's Archiv f. Physiologie,* Vol. 127, 1909) in the course of experiments on glaucoma, was struck by the varying degree of production of opacity of the cornea during the process of water absorption. He found that the transparency of the cornea was but little affected either by drying or by absorption of distilled water, but that the addition of acid or alkali produced an immense effect. The order of activity which the various acids displayed in bringing this about in no way corresponded with their power as regards the facilitation of water absorption. Further, the non-electrolytes, glycerine, urea, or dextrose, were effective in preventing the development of opacity of the cornea, while the electrolytes, which prevent the absorption of water, were found to assist the process of rendering the cornea opaque. The author suggests that this action must be due to destruction of some important part of the corneal proteid, and that some explanation of this nature underlies those opacities, not only of the cornea but also of the lens, which accompany such disturbances of metabolism as are found in diabetes.

Pfalz (*Ophthalmic Year-Book,* 1909) seeks to determine the relative influence of the form, extent and location of an opacity upon the visual function. After making drawings of every case seen the past

year, he concludes that, after all, the condition of the surface has more influence upon sight than the extent of the scar, and that the testimony of the keratoscope must be added to the data as to form, situation, etc. The property of lowering vision possessed by corneal opacities depends not so much upon their light-destroying powers, as upon irregular facetted refraction, not only of the surface of the opacity itself but of the relatively clear cornea in its neighborhood.

In *dense leucomata* (preferably in the non-adherent varieties) when the tension is normal, projection not much impaired and the eye free of irritation, transplantation of the *human* cornea offers a fair chance of vision. As will be seen by reading the caption, **Cornea, Transplantation of the,** recent improvements in the technic of this hitherto doubtful procedure lead us to believe that it is now a useful operation.

The *Ophthalmic Year-Book,* in reviewing some of the recent literature on this subject, remarks that there is a general agreement that dionin is of value in helping to clear up recent corneal opacities; but less evidence exists of its power over those of long standing. In a case reported by Brown the opacities had been present for eighteen years, following inflammation when the patient was ten years old. Dionin was used in 5 per cent. solution twice daily. At the end of two months vision had improved from 5/22 and 5/60 to 5/9 (?).

Moret recommends the treatment of corneal leucoma by warm atomized sulphurous water. He prefers that of Challes in Savoy, as containing the largest proportion of sodium and hydrogen sulphids. The applications are continued from three to five minutes or longer for eyes that have become accustomed to them. If too severe the natural water may be diluted. Temperature can be regulated by the distance of the eye from the jet. He reports two cases of distinct improvement of vision under this treatment.

Ohm, in a weakly girl, with band-like opacities of the corneæ, which eighteen months before had not improved under atropin, cocain and dionin, tried subconjunctival injections of 1 per cent. solution of potassium iodid. In less than two months vision rose from 4/36 to 4/5; and from recognition of hand movements to 4/7. The clouding had cleared in the center of the cornea, although peripheral portions were but little changed.

For tattooing the cornea Ohm has used an instrument made by attaching two or four needles to the massage button of an electric vibrator. With this he claims that tattooing becomes a rapid and exact process. In a case reported by Gallemaerts, the pigment used to tattoo a corneal opacity had migrated into the deep layers, forming a limited plaque at the center of the cornea. Two cases of successful

optical iridectomy for corneal opacity are reported by Burton, who emphasizes the importance of judgment in the selection of cases for this operation.

A case of lead opacity of the cornea, seen by Elliot, was situated in the lower portion, and covered more than two-fifths of the whole corneal area. It was scraped freely, but this did not reduce the opacity. The conjunctival sac was then flushed with an aqueous solution of hydrogen sulphid, which was freely swabbed into the surface of the ulcer, making the patch brown and no longer noticeable. The effect continued the three weeks the patient was under observation. For leucoma resulting from small-pox in childhood, Streiff tattooed the center of the cornea with Chinese ink to represent the pupil, and imitated the iris by tattooing separately with the ink and with gold dust. The latter was moistened with 1 to 1,000 mercuric chlorid solution, and applied like the ink after the removal of the epithelium. Three or four sittings were required, and the result was considered highly satisfactory a year later. Chance enucleated the eye of a young woman which had been tattooed for complete leucoma in childhood, the distribution of pigment having made it unsightly. It showed black lines radiating from a central area, and a dark zone at the corneal periphery. The pigment was most dense immediately beneath Bowman's membrane, and from there was distributed as far as the middle third of the cornea. Most of the lymph spaces contained it. Chance believes there had been a continuous, slowly-acting cyclitis through which the ink was dislodged, and drawn into the lymph-spaces and deposited at the limbus. See, also, **Cornea, Regeneration of the.**

Cornea-orbicularis reflex. See **Cornea, Reflex of the.**

Cornea, Oval. The question as to the causes of decidedly astigmatic corneæ always raises the possibility of hereditary syphilis. Eppenstein (*Zeit. f. Aug.*, 27, March, 1912, p. 237) examined the corneæ of 100 persons with regard to its form. Fifty of these, with the exception of one child, had parenchymatous keratitis. Hereditary lues was definitely proved in the great majority by a positive Wassermann reaction. In the other fifty there was neither a clinical nor a serological reason to assume hereditary lues. The larger linear diameter and the one at right angles to it were measured, radii and the astigmatism was determined with the ophthalmometer. These systematic examinations showed that both in healthy and diseased persons the cornea frequently had no uniformly regular shape. Hereditary lues, *per se*, does not seem to produce ovoid corneæ, so that other causes for the abnormal shape must be looked for. As pointed out by Hess, abnormal shapes

of the cornea may accompany or have the same significance as asymmetry of the face.

Fuchs inferred from his examinations of fifty cases of recent parenchymatous keratitis, that the vertically oval form of the cornea is found not very frequently nor exclusively in hereditary luetic individuals, but more often than in others.

Eppenstein concludes that alterations in the shape of the cornea, especially the vertically oval form, may occur as anomalies of development, or from a disproportion between the resistance of the cornea and intraocular tension. Hereditary lues does not lead directly to this change, but may indirectly produce it through parenchymatous keratitis, occasionally, perhaps, by general deformity of the bones of the face. See, also, **Syphilis of the eye.**

Cornea, Pannus of the. See **Pannus**; as well as **Trachoma.**

Cornea, Papilloma of the. Papillomata are, as a rule, innocent new formations in which there is a thickening of the epithelium on the surface without any tendency to extend downward.

Papilloma of the cornea was first described by Gayet (1879), occurring in a man of sixty-seven, which probably started at the limbus and involved nearly the whole of the cornea. The tumor consisted of papillæ which occupied the region of Bowman's membrane. The mass was covered by corneal epithelium.

Cases have been reported, among others, by Ayres, Baas, Bowman, Lagrange, Weidler, and Coover. Ayres' case did not differ from Gayet's. The papillæ in Baas' case were covered by horny epithelium. Bowman describes his tumor as a warty condition in which there was an epidermoid epithelium over a hyperplastic scar. In Coover's case, a male, æt. sixty-six, the tumor developed eight months after the removal of a supposed pterygium from the outer side of the eyeball, at the site of the resulting cicatrix.

The following is a description of the pathological findings in this case: Sections from different parts of the growth present the same general appearance, viz., a very thick layer of squamous epithelium of irregular outline, beneath which are papillæ of delicate connective tissue. The epithelial layer occupies over one-half of the sections in depth and about the same proportion laterally. The external layers of cells are large, many of them elongated, and although some have evidently undergone keratine degeneration, most of them have deeply staining nuclei.

Underneath the external layers the cells assume different shapes, some being ovoid, some round, fusiform and polyhedral in shape, but all are large cell bodies with deeply staining nuclei. A distinct line

of demarcation is seen between the epithelium and the underlying connective tissue, there being no tendency on the part of the epithelium to invade the surrounding tissue. The papillæ consist of delicate connective tissue fibers and support a moderate number of small blood vessels with apparently normal walls. A moderate amount of blood has infiltrated the base of the neoplasm.

The only treatment of these tumors is excision, which can generally be done under local anesthesia.—(J. D. L.)

Lauber (*Zeitschr. f. Augenheilk.*, p. 254, 1906) gives instructive reports of two cases. Briefly abstracted they are (1) a man, aged forty-three, suffering from old trachoma, noticed for three months the growth of a whitish tumor on his right, opaque cornea. At the lower border a tumor, 15 mm. high, of bluish-pink color, was firmly attached, commencing in the conjunctiva near the limbus and reaching 3 mm. into the cornea. It was removed with a spatula, leaving a facet on the cornea. Its bulk consisted of epithelial cells, which covered scanty papillæ and blood vessels. The stroma of the papillæ contained loose connective tissue with round cells, and was abundantly vascularized. (2), The right eye of a woman, aged sixty-two, was injured by lime three years before. Shortly afterward a tumor developed on the conjunctiva, which was removed. Within the last year a group of tumors grew from the temporal, lower and nasal portions of the sclero-corneal junction. One was situated on the cicatrized area of the cornea, the peduncles of the other came from the conjunctiva. All were of a pale-red color and were composed of small lobules. The peripheral portion of the cornea was covered by a thin, vascularized tissue. The tumors, cut off with a lance-shaped knife, contained more papillæ than those in the first case and very numerous vessels of considerable caliber. Deviating from similar cases, the epithelial layer was separated from the stroma by a thin basal membrane.

Both cases demonstrate, quite in accord with general experience, that papillomas of the cornea always develop on the soil of former vascularization, brought about by inflammatory or traumatic processes.

In the case of papilloma reported by Weidler (*Archives of Ophthal.*, p. 175, 1913), the patient was a man of sixty-one years, and the tumor, which had been developing for three years, measured 12x8 mm. At one point there was some indication of carcinomatous change. See, also, **Tumors of the eye.**

Cornea, Paracentesis of the. The main indications for this operation are to relieve acute pain and to permit the better action of iridoplegics and cyclopegics in iritis and irido-cyclitis; and to precede iridectomy in some acute cases of glaucoma, in which general anesthesia is con-

traindicated and in which there is a question of the performance of an iridectomy. It is also of value in some rare instances in which it would not be wise, for some reason or other, immediately to attempt to remove some gross form of mechanical pressure upon the intraocular lymph circulation, as in dislocation of the crystalline lens; and in threatened perforation of a corneal ulcer. By some, it has been used tentatively (and, of course, most judiciously), as an adjunct to massage in cases of intraocular embolism and thrombosis. It forms a part of the surgical treatment of keratoconus. Very rarely, indeed, it has been used to advantage for the removal of blood clots situated within the anterior chamber.

In the first volume of Monteath's translation of Weller's Manual (*A Manual of the Diseases of the Human Eye* (English Translation), 1821, page 225; from Weller's *Die Krankheiten des Menschlichen Auges*, 1819) we find the interesting editorial avowal that "The English now employ the evacuation of the aqueous humor, by means of a needle, very commonly, in inflammation of the eye."

In confirmation of this, it will be found that as late as 1840, Mackenzie (*A Practical Treatise on Diseases of the Eye*, American Edition, 1833, p. 410), Middlemore (*A Treatise on the Diseases of the Eye and its Appendages*, 1835, Vol. I, pp. 462-463) and Tyrrell (*A Practical Work on the Diseases of the Eye*, 1840, Vol. I, p. 236) made use of the method.

Wardrop has written extensively upon its usefulness. He performed it with a narrow cataract knife introduced into the anterior chamber near the corneal margin with its flat surface held parallel to the plane of the iris. He states that when the desired depth has been reached, the instrument is slightly turned upon its axis to facilitate the escape of the fluid. It should not be allowed to touch the iris. He made use of the procedure as an auxiliary treatment in all cases of hypopyon. (*Medico-Chirurgical Transactions*, Vol. IV, p. 142. Also see an interesting paper bearing upon the rationale of the subject in *The Edinburgh Medical and Surgical Journal* (2d series), Vol. III, p. 56.) Lawrence (*A Treatise on the Diseases of the Eye*. American Edition by Isaac Hays. 1847, p. 378) has practised it without any injury to the intraocular structures. Macgregor (Ibid., p. 378) states that "It is to be regretted that this operation is not more frequently performed; for I am convinced that many persons have lost their sight from rupture of the cornea taking place in front of the pupil, which a timely and judicious performance of this operation might have prevented." Both Mueller and Langenbach (Loc. cit.) think well of it; while Vetch (*A Practical Treatise on the Diseases of*

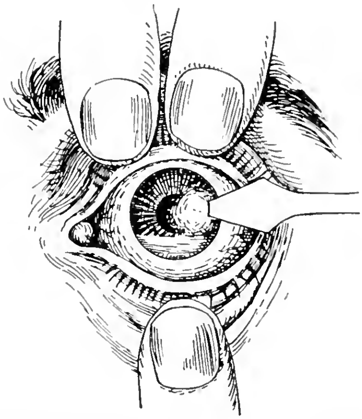
the Eye, 1820, p. 42) says that the "testimony which I have to offer on this subject goes more to establish the safety than the expediency of the operation." Benedict and Rosas (Ibid.) have used it in iritis; the latter injuriously so. Carel (*De la paracentèse de la chambre antérieure dans le traitement de l'hypopion. Thèse de Paris,* 1872) and Diaz-Albertini (*De la paracentèse de l'œil dans les cas d'ulcères perforantes de la cornée. Thèse de Paris,* 1856) speak of its employment in the treatment of hypopyon and perforating ulcers of the cornea.

The procedure is made as follows: General anesthesia is necessary only with children, and in non-contraindicated adult patients who are greatly depressed and suffering from intensely inflamed and hypersensitive eyes. After thorough cleansing of the parts, the eyelids are gently separated. This is best done by the fingers of a competent assistant. The incision, which is generally made with a narrow, bent keratome, or in some cases in which the anterior chamber is shallow, with a narrow lance knife, must be situated to the very best advantage in each individual case. Interference with the iris and the lens capsule should be avoided during the procedure. When the blade of the cutting instrument has been gotten to its proper position, it is tilted slightly to one side, so as to slowly evacuate the anterior chamber of its liquid and solid contents. The knife is then quietly withdrawn, care being taken to keep the patient still during this part of the procedure, which, as a rule, is found by some to be quite painful. The same deliberation and quietude of action is required if the lance knife is used. In order to remove any remaining material which should be taken out, a pair of fine cystectomy forceps or a flat spatula carefully introduced, may be necessary. As a rule, flushing of the chambers with a warm normal solution of salt through a bulb syringe, will accomplish the same purpose. Should the iris become prolapsed, which is not very probable if the procedure be judiciously done, it can be replaced, or, in most cases, better, excised.

In case of sloughing ulcer of the cornea, after analgization of the conjunctival sac with cocaine, the eyelids are separated by a stop speculum (although its use is by no means necessary in many instances). This done, a Beer knife, or preferably, a knife-needle, is passed through the cornea at the peripheral margin of the ulcerous area. The moment that the anterior chamber has been well entered, the breadth of the blade is carried across the incision, thus making an opening through which the contents of the anterior and the posterior chambers are allowed to make exit. Just as before, care must be taken not to injure the iris or the lens capsule. Atropine should be instilled,

the operation field cleansed, and the eyeball covered by a protective bandage. Hot stupes can be applied directly over the bandage. Incarceration of the iris in the corneal wound must be guarded against: For this purpose, in measure, the writer makes use of atropine. According to some surgeons, it may be well in some cases to employ eserine so as to keep the iris tissue tense in order to prevent its prolapse into the wound. If the wound, however, be made oblique, there is but little danger of such incarceration.

The accompanying sketch gives a fair illustration of the method as pursued and depicted by Stellwag.



Paracentesis of the Cornea. (Stellwag.)

In the performance of paracentesis for corneal ulcer, Schell (*A Manual of Ophthalmic Practice*, 1881, p. 60) gives preference to the introduction of the needle through the corneo-scleral ring in such a way that the iris and the lens cannot be wounded.

In cases of slowly-healing injuries to the cornea, in which the endothelial layer of the membrane is pressed outward in the form of a minute hernia, Colburn (*Clinical Lectures on Diseases of the Eye*, 1902, p. 208) practices paracentesis of the cornea to lower tension of the eyeball. "The aqueous should be drawn out through the pericornea, thus allowing the hernia to recede and the ulcer to close up." He believes that the use of the galvano-cautery may be required to stimulate the process of repair. He enters the anterior chamber to the scleral side of the corneal junction. The instrument, which may be either a paracentesis needle, a bistoury, or a Graefe knife, must be directed in the plane of the iris. When the chamber is entered, the instrument must be rotated just enough to allow the aqueous humor

to slowly escape, and should be withdrawn before it is touched by the iris.

Bert Ellis (*Presessional Volume,* Section on Ophthalmology of the American Medical Association, 1907, p. 294) makes repeated use of the method in cases of impending perforation of the membrane.

Fuchs (*Lehrbuch der Augenheilkunde,* 1903, s. 181) considers paracentesis of the cornea a valuable early aid in the prevention of threatened ulcerous rupture of the cornea. He performs it with either a lance knife or a von Graefe cataract knife. The puncture is made about two to three millimeters in length, the lips of the wound being carefully set into proper relationship by the aid of a Daviel's spoon.—(C. A. O.)

Cornea pellucida. Synonym of cornea, the *transparent* cornea, as opposed to *cornea opaca*, the opaque cornea or sclera.

Cornea, Pemphigus of the. KERATITIS BULLOSA. VESICULAR KERATITIS. KERATITIS VESICULOSA. This rare variety of vesicular corneal inflammation occurs chiefly in middle-aged or elderly persons. It may be found in eyes which previously have been normal, but more often it occurs in those which are affected with glaucoma, iridocyclitis, or corneal cicatrix. A few cases are due to trauma, such as abrasion of the cornea by the finger-nail. The characteristic feature of the disease is the formation of a large vesicle, or bulla, which involves the outer part of the corneal surface and is tremulous. After a few days the vesicle ruptures, and coincidently there is great pain. The anterior wall of the vesicle, consisting of the epithelial layer (sometimes the deeper layers) of the cornea, is not shed, but remains *in situ.* After a variable time it is lifted up by fluid, bursts again, and this process is often repeated for many weeks. Ciliary injection, photophobia, lachrymation, increased tension, and pain are prominent symptoms during the development of the vesicle. Often these symptoms subside after the vesicle bursts. Fuchs explains the origin of corneal bullæ as follows: In glaucomatous eyes lymph-stasis causes an interstitial edema and results in lifting up the epithelial layer; if the fluid penetrates Bowman's layer, the latter also is lifted up.

Prognosis in bullous keratitis is unfavorable. During the height of the disease the eye is painful, and vision is much reduced or entirely lost. After recovery the cornea remains opaque. There seems to be no tendency to involvement of the second eye. Under the most skillful treatment the disease will continue for weeks or months.

Treatment should aim to relieve pain and irritation and reduce increased tension. The use of collyria of holocain and cocain gives only temporary relief. Removal of the anterior wall of the vesicle and the

application of strong solutions of silver, or burning with the galvano-cautery, may be followed by improvement. If the intra-ocular tension is increased and does not yield to arecolin, pilocarpin, or eserin, an iridectomy should be made. Attention should be given to the general health. In some cases tonics and antiseptics can be used with benefit. If vision is lost, and recurring crops of vesicles make the patient miserable, enucleation for the relief of pain may be a justifiable operation.—(J. M. B.)

Cornea, Perforation of the. This complication may result from trauma and operative measures, but it is usually associated with serpent ulcer and other forms of spreading or deep infection of the cornea. See **Cornea, Serpent ulcer of the.**

Cornea, Peripheral brownish-green coloration of. See **Cornea, Melanosis of the.**

Cornea, Perithelioma of the. CORNEAL ENDOTHELIOMA. This rare formation will be considered in connection with sarcoma of the cornea (q. v.).

Cornea, Phlyctenules of the. SCROFULOUS KERATITIS. PHLYCTENULAR KERATITIS. STRUMOUS OPHTHALMIA. TUBERCULAR KERATITIS. Although this subject will be more exhaustively treated under **Keratitis, Phlyctenular,** it may be said here that it is a disease characterized by the appearance of single or, more frequently, multiple efflorescences or papules in the most superficial layers of the cornea, and usually is confined to the limbus. The disease commonly affects children, but sometimes develops in adolescents. The distinguishing features are that it is frequently preceded or accompanied by phlyctenules of the bulbar conjunctiva. The nodules form and cicatrize in cycles and only in rare instances are they followed by marked or permanent opacities; in other words, they do not, as a rule, attack the deeper layers, or cause perforation of the cornea. The phlyctenules vary in size from a millet seed to a large pea. In severe cases, the phlyctenulæ are so numerous that the cornea has the appearance of having had fine sand sprinkled over it.

In the *avascular form* (solitary phlyctenule) the involvement is usually restricted to a small, single efflorescence situated near the corneal center and accompanied by a localized ciliary injection. When the lesions are multiple and located near the limbus, conjunctival injection (which may mask the ciliary vascularity) becomes pronounced.

The *vascular forms* vary from moderate conjunctival and ciliary injection to that in which newly formed blood-vessels are so numerous that to the condition has been given the name of *phlyctenular pannus.*

The new vessels do not run deeper than the epithelial layer, close to Bowman's membrane, and their presence gives to the cornea an elevated and roughened appearance. In the form known as *vascular fasciculus* (Fischer) a leash of parallel blood-vessels runs from the scleral margin to the phlyctenule at the corneal center. When this process involves the deeper corneal structures, the newly formed blood-vessels appear beneath Bowman's membrane.

A phlyctenular process sometimes assumes serpiginous characteristics, in which the disease manifests a creeping tendency as it spreads along the corneal surface.

Microscopic examination of the contents of a phlyctenular vesicle fails to reveal the presence of microorganisms; later, they may be present from secondary infection.

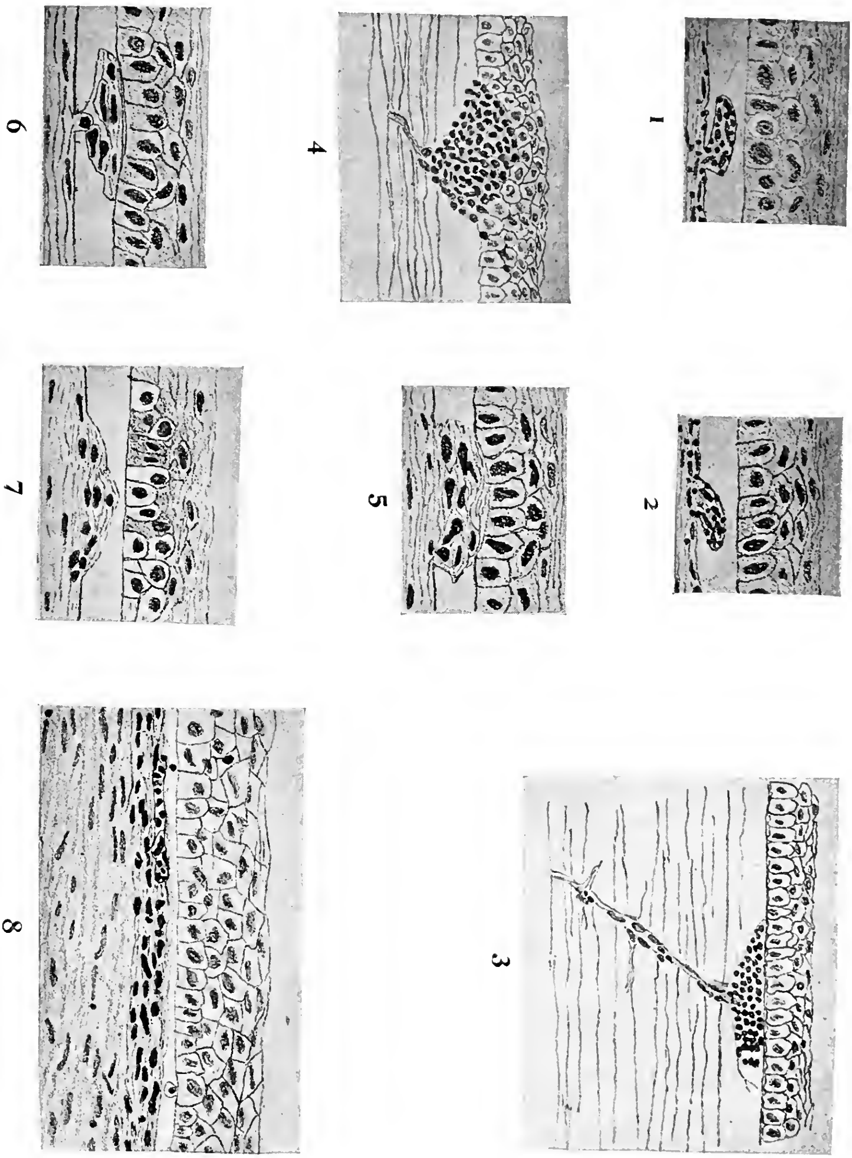
As the disease is often of tubercular origin, one must assume that the condition generally has its origin in tuberculo-toxic substances.

The efflorescences begin with an infiltration of leucocytes beneath Bowman's membrane and afterwards affect the superficial layers of the lamellæ. The epithelial layers are elevated as a result of the underlying infiltration and when the invasion reaches a certain point, this tissue, along with Bowman's membrane, breaks down and the loss of substance converts the papule into an ulcer.

The initial *symptoms* are characterized by the most intense and annoying photophobia, profuse lachrymation and blepharospasm. In the later states of the disease it may be impossible for the child to open his eyes or for the surgeon to make a complete examination of the eye without resort to local or general anesthesia and lid elevators.

Appropriate *general treatment* directed to the systemic dyscrasia is imperative in these cases. *Locally,* atropine and dionin, as well as dusting with calomel, combined with light cauterization of the ulcers with nitrate of silver or iodine and phenol, are dependable remedies.—(J. D. L.)

Rubert has been able to produce in rabbits and guinea-pigs lesions quite similar to phlyctenules in man, by the instillation of old tuberculin, either of the human or bovine type, into the sound conjunctiva, confirming the observations of Rosenhauch and others. He believes a general tubercular infection of the organism is the underlying basis of phlyctenular disease, and that the supposition of intestinal auto-intoxication is not admissible. On the other hand, Colombo, from his study of the so-called scrofulous or eczematous kerato-conjunctivitis, is inclined to accept the hypothesis of an "exudative diathesis" characterized by affections of the skin and mucous membranes, and arising from intestinal intoxication. In forty-three cases he found indican



Microscopical Sections of Phlyctenules of the Cornea. (Baas.)
Showing (1) and (2) beginning phlyctenule; (3) developed phlyctenule; (5), (6) and (7) scar following the healing of a phlyctenule; (8) phlyctenular pannus.

always present in the urine, in variable amount; one day only a little, the next day perhaps a much larger quantity. He holds that in some cases the quantity of toxic substances of intestinal origin may be alone sufficient to cause phlyctenular disease, while in others it produces the effect by acting on tissues with resistance lowered by tubercular or other disease. See, also, **Conjunctivitis, Phlyctenular,** and **Keratitis, Phlyctenular.**

Cornea, Phthisis of the. When ulceration has been maximum in its destruction, the entire cornea, except a narrow area at the periphery, succumbs. Such an extensive sloughing process is naturally attended by complete prolapse of the iris. The destroyed area is then replaced by a perfectly flat scar, considerably smaller, however, than the normal cornea. To describe this condition the expression *phthisis corneæ* is sometimes employed.—(J. D. L.)

Cornea, Pigmentation of the. See **Cornea, Melanosis of the.**

Cornea, Pitting of the. FUCHS' DELLEN. GAULE'S PITS. Fuchs (Graefe's *Arch. f. Ophth.*, Vol. 68, p. 82, 1911) designates as "Dellen," round or elliptical, shallow depressions of the cornea, with smooth edges, varying from 1 mm. to 3.5 mm. in diameter, usually located near the periphery. They occur with swelling of the conjunctiva and sclera; after cocain; after cataract operations; with hemeralopia; in paralytic lagophthalmos; or spontaneously in elderly subjects. They are to be differentiated from Gaule's pits, which are smaller, not so deep and confined to the center of the cornea. They may form under a bandage, whereas Gaule's pits follow exposure of the cornea to air, without moisture. The most probable cause is a disturbance of innervation.

Cornea, Polypoid growths of the. EXUBERANT GRANULOMA OF THE CORNEA. MYXOMA OF THE CORNEA. These are pedunculated tumors, smooth, reddish, and composed of irregular, globular masses. They sometimes appear after perforating ulcers of the cornea, or follow a chronic suppurating keratitis.—(J. D. L.)

Cornea, Pressure-opacity of the. This condition usually develops secondary to, and is the result of, increased intraocular tension; but it sometimes appears in connection with other diseases. The cloudy area of the cornea is most pronounced at its center and the tissue changes are confined principally to the epithelial layers which upon close inspection are seen to be uneven, owing to the detachment of the cells from Bowman's membrane. In advanced cases, minute vesicles, or blebs, may appear on the cornea. Pressure opacity develops directly as the result of some interference with the normal circulation in the corneal lymph streams. Opacification due to glaucoma appears most

frequently in the inflammatory types and is especially prone to occur when the tension is suddenly elevated. The corneal haze resulting from increased intraocular pressure disappears (except in protracted cases) with the return of normal tension. The loss of transparency should not, accordingly, be regarded as a true edema but as probably caused by an increase or change in the refractive index of the corneal fibrillæ.—(J. D. L.)

Cornea, Prickle cells of the. Piersol defines these as irregular polyhedra, constituting the middle strata of the epidermis. They are connected with each other by delicate processes that join the intervening intercellular clefts and establish direct continuity between neighboring cells. They are also found in the middle layers of the cornea. See **Histology of the eye.**

Cornea, Progressive ulcer of the. See **Cornea, Serpent ulcer of the.**

Cornea, Reflex of the. WINKING OR PALPEBRAL REFLEX. CORNEA-ORBICULARIS REFLEX. This subject is discussed under **Cornea, Sensibility of the.** It may be added here that a common esthesiometer for testing the corneal winking reflex is a piece of long-fibered cotton (wool) twisted to a point. The lids should close instantly on touching the *periphery* of the cornea, so as to induce a genuine orbicular reflex and not merely a visual or *retinal lid-closure reflex.*

Several investigators have observed disturbances of the corneal reflex phenomena in association with endocranial lesions. Oppenheim asserts that the absence of the corneal reflex is pathognomonic of growths in the posterior cranial fossa. Reich saw a case of tumor of the right frontal lobe in which there was right-sided absence of reflex. Hamburger observed a diminished corneal reflex and right-sided paralysis of the external rectus in a case of left-sided glioma of the dentate nucleus. Hübner saw right-sided hyporeflexia associated with a right-sided frontal abscess. Milian considers the loss of corneal reflex a diagnostic sign of hemiplegia in coma, and when unilateral abolition of reflex is present he regards the phenomenon as a sign of a focal lesion in the zone of Rolando.—(J. D. L.)

The diagnostic significance of loss of corneal reflex is discussed by Saenger, who has also seen it as a symptom of tumor in the posterior cranial fossa. Usually it affects but one side, the opposite from the side on which the lesion causing increased intracranial pressure is situated. Very rarely the loss of reflex is noticed on the same side as the causative lesion.

Cornea, Regeneration of the. Cases of regeneration of a considerable portion of corneal tissue have been observed by Jusélius, Armaignac, Darier, Callan, Salzer, Wolfner, Wiener and others. In nearly all the

cases blennorrhea was responsible for the original lesion of the cornea, and the destruction had extended to Descemet's membrane.

Wiener's experiments upon the cornea of rabbits have made him optimistic regarding the resection of corneal scars (under aseptic conditions) for the improvement of vision. In studying the regenerative process in the cornea of 31 rabbits, he noted, 24 hours after removal of all of the tissues down to Descemet's membrane, a stippled appearance of the denuded surface, with edges rounded and elevated. At the end of 48 hours the edges had extended several millimeters, and in a few days the entire area was covered by nepheloid tissue which became clear in from four to six weeks, leaving quite faint nebulæ, visible only by oblique illumination. The regenerated corneal tissue was at first thin, but gradually became thicker.

Jusélius made histological examinations of regenerated corneal tissue after removal by a von Hippel trephine. He noted that when the karyokinetic wave, starting at the limbus, reaches the edge of the wound, regeneration begins and that the defect is filled in by cell-division. He noted that warm moist compresses aid, but cold applications retard repair of these corneal defects.

Wolfner saw the cornea of a woman, aged 32, regenerated in two months after all the substantia propria had been destroyed by gonorrheal ophthalmia. The new-formed tissue was cloudy at the beginning of the regenerative process, but at the end of a year it had cleared sufficiently to give 14/120 vision.—(J. D. L.)

Cornea, Relapsing erosion of the. This condition commonly appears from a few days to several months after injury to the cornea, when the healing process seemed complete. The onset is sudden and upon close inspection with the loupe, some loss of epithelium is seen over the previously affected area, which stains with fluorescein. Usually only the superficial cells are lost but occasionally large vesicles (bullæ) may develop from accumulations beneath the epithelium.

Acute pain, neuralgic in character, lachrymation and intense photophobia, mark an attack. When the destroyed epithelium has been replaced, the symptoms subside only to recur with the relapses, each of which may persist from a few days to several months.

Schroeder advises touching the denuded area with a 2 per cent. solution of silver nitrate. Weeks (*Text-Book*, p. 288) recommends curetting the affected surface and applying a 10 per cent. formalin solution, to be followed every four hours by inunction of 3 per cent. borated vaselin within the conjunctival sac. The eye is kept bandaged. Dionin 5 per cent. solution is a valuable remedy for this condition. Holocain, as shown by Verhoeff, is an unrivaled remedy for all forms

of superficial keratitis; and is valuable in the treatment of corneal erosions.—(J. D. L.)

The Ophthalmic Year-Book for 1910 gives the experience of other observers. Cauvin observed hypotonia in corneal erosion during the neuralgic attacks. Between the attacks there is hyperesthesia. Vesicles or erosions may be present; the former he found to be more frequent. There is generally but one vesicle, but in one case he found five. The erosion may escape notice unless stained. The epithelium may regenerate in a few hours, but the neuralgia persists with intervals for three or four days. Generally the neuralgia ceases by the eighth day. There is generally no febrile disturbance. The case may get well or continue to be subject to subacute attacks. These begin a number of days or even weeks after recovery from an acute attack. The patient awakens in the night or morning with a feeling of heaviness in the lid and difficulty in opening the eye. When the eye is opened there issues a flood of tears. These attacks may continue at intervals for a number of years. See, also, **Cornea, Neuralgic herpes of the.**

In general the intervals grow longer with time and the attacks less severe. Cauvin further remarks that Szily found intracellular vacuolization with shrinkage of the nuclei. There were lesions of continuity in the epithelium and some accumulation of leucocytes. The intercellular gaps had a sharp outline and a base of flattened epithelium. Szily thought that the erosion was caused by the newly-formed epithelial cells not being in close relation with the deeper layers. Hansen believes there is a trophic disturbance in the nerve endings; Grandclement, that the cause is a neuritis of one or more of the corneal twigs of the ciliary nerves, the injury being sufficient to bruise without destroying them. Peters attributes the condition to an edema of the middle layers of the cornea. Cauvin's theory is that there is a neuritis of the smallest filaments of the corneal nerves dependent upon a trophic alteration of nervous or arthritic origin. He found no treatment to be effective. Heat, cocain, aspirin, atropin, acoin oil, bandaging, and a dionin salve rubbed into the orbit relieve the symptoms and favor healing.

Wirtz reports cures after the applications of zinc iontophoresis. By curetting, Klein cured an erosion following a burn from molten zinc, after it had resisted other treatment for nine weeks. The epithelium reformed in twenty-four hours. The vision was eventually good. Strader reports a recurrent corneal bleb left after a burn with zinc chlorid. Jackson recommends nitric acid in these conditions. Kuwabara experimented with methyl violet, ethyl violet, and gentian violet, in the eyes of rabbits and found that they caused corneal erosion and

in some cases hypopyon and gangrene of the lids. See, also, **Cornea, Erosion of the.**

Cornea, Relapsing herpes of the. This is a synonym (not often used) of *nodulæ corneæ*. See **Cornea, Nodular opacity of the.**

Cornea, Ribbon-shaped opacity of the. F. C. Heath (*Jour. Am. Med. Ass'n.*, July 18, 1908), in discussing the condition variously described as calcareous film, band opacity (Graefe) and ribbon-shaped keratitis, remarks that it may be primary or occur in eyes blind from glaucoma or iridocyclitis. The opacities are punctiform and crowded together, forming a gray stripe across the cornea, occupying the exposed portion of the lid fissure. The disease progresses slowly and sooner or later both eyes are involved. In some cases there are attacks of severe pain, but ulceration is never observed. Most cases occur in men over forty-five. The pathological condition is a hyaline degeneration of corneal cells that later become calcareous. Gout, renal disorders, loss of vital energy in the cornea through vascular changes, repeated irritation of the surface of the eye, as by foreign bodies, are etiologic factors. Graefe noted a resemblance to glaucoma and bad effects of atropin. Sight has been improved by scraping the cornea and by iridectomy. Carbonate of soda, nitric acid, hydrochloric acid, 5 per cent., have been recommended. In Heath's case, scraping and applications of weak carbonate of soda solutions were of no avail. Iridectomy resulted in vision of 15/60, since when the patient had been able to get about alone. (Wood's *System of Ophthalmic Therapeutics,* p. 736.) See also, page 877, Vol. II of this *Encyclopedia.*

Cornea, Ring ulcer of the. ANNULAR ULCER. CRESCENTIC OR CRESCENT ULCER. This unusual form of ulcer is situated at and tends to spread about the margin of the cornea. It is generally seen in elderly people, especially in those who have a chronic catarrh of the palpebral conjunctiva or a chronic dacryocystitis. It probably arises from an abrasion of the epithelium due to the lodgment of a foreign body at the corneal limbus, infection taking place from the conjunctival or other discharge present. A common form of this disease occurs in farmers, whose eyes are liable to injury from the flying stems and other parts of wheat or hay. An abrasion of the cornea is the result and infection follows.

It usually takes the form of a deep ulcer with infiltrated edges, that spreads along the corneal margin instead of extending towards the pupil as in ordinary serpiginous ulcer. The older ulcer may heal while the recent necrosis gradually extends, although destruction of the whole cornea may occur from interference with its nutrition, especially

if the ulcer has already eaten completely around the sclero-corneal junction, in which case the eye may be entirely destroyed.

Prognosis as regards vision is always bad, while total loss of the eye from perforation of the cornea and panophthalmitis is not uncommon.

Treatment should be carried on actively, with atropin, mild antiseptic solutions and hot applications. The general health should be built up by the internal administration of iron, quinin, etc., and a nutritious diet. If there is danger of perforation a solution of eserin, $\frac{1}{4}$ to $\frac{1}{2}$ per cent., may be instilled into the conjunctival sac in order to contract the pupil and render prolapse of the iris less likely. In such a case paracentesis through the floor of the ulcer should be performed without delay. The early and thorough employment of the actual cautery is here indicated and it should be repeated if necessary.

S. H. Brown (*Ophthalmology*, Jan., 1911) reports a case in the left eye of a man, æt. 60. Four weeks previous to his first visit he had experienced some pain and distress in the eye, which got much worse in the succeeding two weeks and then began to subside. Brown at this time examined him and found the eyelids and lachrymal apparatus normal; chronic catarrhal conjunctivitis was present; pericorneal injection was marked; almost the entire outer half of the cornea was white; about one or two millimeters from the corneal margin, separated from it by clear cornea and running parallel to it for half of its course, was a crescentic groove in the cornea, at either extremity of which were evidences of active ulceration. The pupil was contracted and bound down by posterior synechiæ. The opacity of the cornea prevented ophthalmoscopic examination of the fundus. The patient could count fingers at six inches. Bacteriologic findings were negative.

Treatment consisted in the use of boric acid solution, atropin and iodoform ointment, and a protecting bandage with slight pressure. The extremities of the ulcer were cauterized with carbolic acid.

The crescentic groove began to fill up, and the iodoform was discontinued. A 5 per cent. dionin solution was instilled daily for a week and gradually the pericorneal vessels extended over the site of the ulcer. Atropin was then used sparingly and the bandage continued. The dionin was withheld for four or five days, after which it was used again. Tonics, anti-rheumatic remedies and vapor baths were also administered.

Three months after his first visit the cornea was entirely free from ulceration, the cornea was nebulous for its outer half, but there was no staphyloma. The patient had only light perception in this eye at the time of discharge.

Five cases of annular ulcer following accidental trauma of the cornea, and one after a cataract operation, are reported by Tertsch, with one in which injury had occurred during sleep, and one of ring abscess complicating sarcoma of the choroid. The eyes were all enucleated and submitted to histologic and bacteriologic examination. Inoculation of the corneæ of animals in no case caused ring abscess. In two cases the organism found was the bacillus subtilis. Tertsch concludes that ring abscess is part of a severe pathologic process affecting the interior of the eye, and that the eye is always lost. In a case reported by Cramer the injury was in the corneal epithelium, by a particle of dust. The conjunctival secretion contained pneumococci and staphylococci. In the inoculated eye of a rabbit, a ring of infiltration formed in front of Descemet's membrane. In a case reported by Patterson the eye partially recovered. There had been no injury to the cornea, but the patient was convalescent from pneumonia and herpes occurred on the lip of the same side, when the eye became affected. The staphlyococcus aureus was present; and a stock vaccine of this organism was administered four times in nineteen days. After the last dose improvement was rapid, and the cornea cleared sufficiently to permit counting fingers.

Terlinck (*Bull. de la Soc. Belge d'Ophtal.*, 1912) reported the case of a patient who had dilatation of the lachrymal sacs for several years and who developed an acute attack of dacryocystitis with profuse suppuration; following which an annular corneal ulcer appeared, touching the limbus. The ulcer, of variable depth, did not show serpiginous characteristics; there was no hypopion. The etiological cause proved to be the pneumococcus, presenting some of the characteristics of the streptococcus. Resulting vision, 20/50. A similar affection in the other eye resulted in a large annular leucoma with staphyloma of the pericorneal zone of the cornea and only 1/200 vision.

Cornea, Rodent ulcer of the. MOOREN'S ULCER. ULCUS RODENS CORNEÆ. See **Cornea, Mooren's ulcer of the.**

Cornea, Rupture of the. This heading properly belongs to **Injuries of the eye,** but a few instances of this rather common trauma may be mentioned here.

Komoto observed corneal rupture from a blow. The case was in a woman of sixty who had suffered from redness of the eyes at the menstrual periods until the age of forty. Gerontoxon was absent. The other eye had marked arcus senilis with peripheral groove formation between it and the limbus.

On the other hand, *spontaneous rupture* is extremely rare. The

Ophthalmic Review gives an abstract of the paper by Fage (*L'Ophtalmologie Provinciale*, February, 1909) on spontaneous rupture of the cornea in a case of glaucoma. Coppez was able to collect only a dozen or so of such (published) cases. Fage relates a case which came under his own care. It was that of a man of sixty-six, somewhat alcoholic and with atheromatous vessels, but without any definite heart lesion and with no albumin in the urine. He had in the left eye absolute glaucoma, with an acute exacerbation lasting some days; in the right eye the condition was in an earlier stage, but there were undoubted signs of glaucoma. Obtaining relief from the acute symptoms in the left eye by means of a miotic and local depletion, he disappeared for several months, when he again presented himself with the story that the eye had kept much in the same state until a couple of days before, when he had experienced a violent pain in it and felt a warm fluid trickling down from it. On examination, the left cornea was seen to have a central ulceration, the membrane itself being dull and insensitive. The actual perforation was a linear slit, its long axis lying horizontally and measuring about 3 mm. There was no prolapse, but the anterior chamber was filled with a clot which protruded through the perforation, whose lips were distinctly a little infiltrated round about; at the foot of the anterior chamber there lay a fine grayish exudate. The eye becoming septic, Fage eviscerated it. That a staphyloma of the cornea, whose walls are thinned and weak, should give way need not surprise us, nor the yielding of an ulcerated cornea, nor the spontaneous rupture which may take place when an intraocular tumor begins to eat into the walls of the globe, though in such a case it is rather the sclera than the cornea which gives way; but spontaneous rupture of apparently healthy cornea is a different matter. In Coppez's case an iridectomy had been done previously; the hemorrhage occurred during a violent fit of anger.

When examined pathologically the ruptured cornea is generally found to show some signs of weakening of the part before the actual hemorrhage takes place. Some writers speak of it as being deprived of Descemet's membrane.

As Fage points out, the whole eye receives much support from the tissues surrounding it (e. g., Tenon's capsule), and can therefore be distended forwards only; if it gives way one might then naturally expect that the point of yielding should be the cornea, all the more that the prolongation of the period of high tension may lead to superficial erosion of the cornea and degeneration of its substance. Opinions are, however, divided as to whether it is hemor-

rhage which can fairly be blamed for the rupture, or the degeneration of the cornea, which becomes unable to support the pressure and suddenly gives way, possibly even undergoing partial gangrene from the extreme pressure on the nutritive channels. In such cases it is probable that the cornea breaks down much in the same wholesale fashion as is seen in neuroparalytic keratitis. Both factors probably have their influence on one another, for the blood-vessels are often (as in Fage's case) atheromatous and brittle and liable to give way even spontaneously. It is known too that in a good proportion of one's cases of glaucoma the intravascular tension is high, this prejudicial condition causing a liability to hemorrhage from sudden giving way of the vessel wall.

Cornea, Sarcoma of the. This is one of the rarest neoplasms of the cornea; in fact, Parsons views the diagnosis of most of the reported cases with suspicion and treats the subject as follows: "The evascular fibrous stroma of the cornea, like tendons and aponeuroses, might be expected to enjoy relative immunity from malignant growths, whilst it is always impossible to exclude invasion from the periphery from which the blood-supply must necessarily be derived. The resemblance of embryonic connective tissue in inflammatory granulations to sarcoma and the loss of the iron reaction in old hemorrhagic pigmentation form insuperable barriers to certitude of diagnosis in the present state of knowledge. Nevertheless malignant proliferation of the fixed corneal corpuscles cannot be definitely eliminated. Should it occur, the disposition of the corneal lamellæ might be expected to give rise to a quasi-alveolar arrangement.

Donaldson's and Fumagalli's cases most nearly resemble the one which has been described as an *endothelioma of the cornea.* Transverse sections of the growth were plano-convex. The convex surface was covered with epithelium, which was flattened, varied greatly in thickness, and was absent near the periphery on one side. The growth consisted of masses of epithelioid cells arranged in an alveolar manner, enclosed in capsules of spindle-celled fibrous tissue. This tissue stained red with van Gieson, and fibrillæ passed between the outer cells of the masses, but the larger central parts were devoid of any definite intercellular stroma.

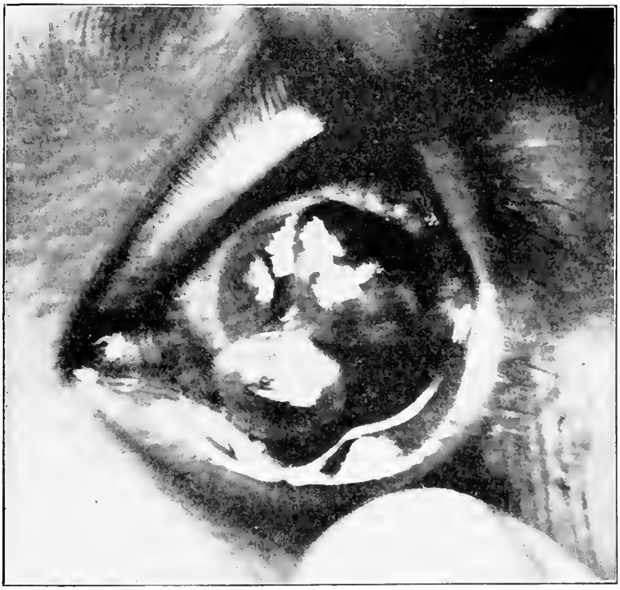
The epithelioid cells varied greatly in size and shape; many showed karyokinetic phases, others atypical nuclear changes. The aggregations also varied in size. They were mostly oval, and the smaller ones invaded the epithelium in places, recalling the conditions found in congenital nevi.

There can be little doubt that this growth was an endothelioma,

and that it originated in the limbus, and is not a true autochthonous corneal growth. There are faint indications of débris of red corpuscles in a few of the alveoli, and this points to blood-vascular endothelium as the origin of the cells.''—(J. D. L.)

The *prognosis* and *treatment* of this neoplasm are practically that of sarcoma elsewhere.

Veasey (*Practical Medicine Series*, p. 165, 1908) gives the history of a man of forty-seven years who noticed a small brownish spot to the temporal side of the sclerocorneal junction for about twelve years.



Sarcoma of the Cornea. (Veasey.)

It suddenly began to grow and increased rapidly in size. It was found to occupy about two-thirds of the corneal surface and extended 1.5 mm. into the sclera. It was firmly attached to the underlying ocular structures, and was dark-brown in color. The apex was ulcerated and bled on the least manipulation. The iris was of good color and the anterior chamber unaffected. The eye was enucleated and examined microscopically by C. M. Hosmer, who diagnosed a primary, melanotic spindle-cell sarcoma. See the illustration.

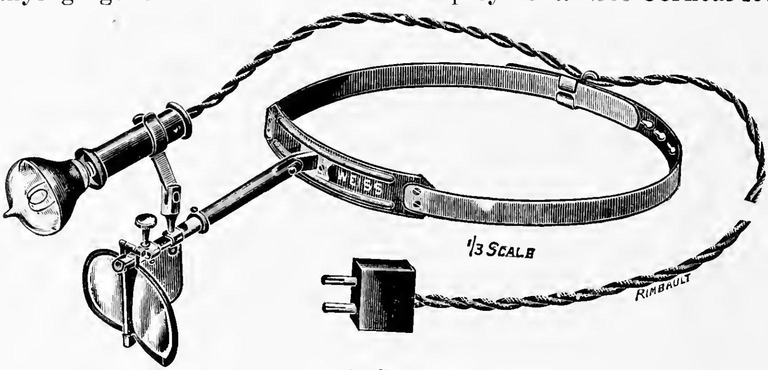
Addario La Ferla saw primary sarcoma of the cornea in a child of eight months. The growth had been first noticed by the mother thirty-five days earlier. It measured superficially 6 or 7 by 2 or 3 mm., and was 4 mm. thick. Microscopic study showed it to be a melanotic

sarcoma, which had begun in the middle of the corneal parenchyma, had destroyed Bowman's membrane, and showed but little tendency to extend backward. In Dean's (*Annals of Ophthalm.*, p. 764, 1913) patient, a woman of sixty-three years, the tumor, a slightly pigmented spindle-cell sarcoma, occupied the central portion of the upper half of the cornea. It had apparently sprung from the superficial layers of the substantia propria, bursting through Bowman's membrane.

Cornea, Scabies of the. This is a very rare condition, clinically a sample of keratitis fascicularis. In one case a female acarus scabei and ova were found in the lesion, and demonstrated microscopically. —(J. D. L.)

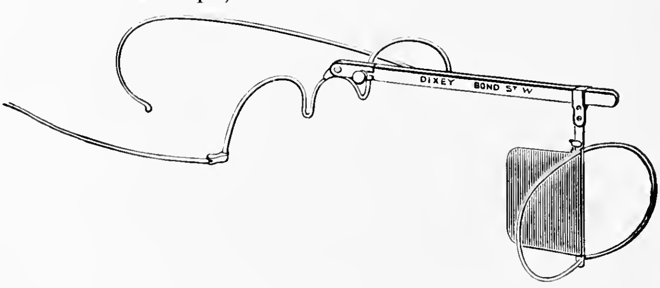
Cornea, Sclerosis of the. CORNEAL SCLEROSIS. A synonym of macula of the cornea. See **Cornea, Opacities of the.**

Corneascope, Hess's. This form of magnifying, self-illuminated, binocular loupe is to be used with a 100-volt electric lamp. The accompanying figure shows the method of employment. See **Corneal loupe.**



Hess's Corneascope.

Corneascope, Treacher Collins'. This binocular loupe is a modification of the Hess corneascope, but the lenses are fitted into a spectacle



Treacher Collins' Corneascope.

frame instead of the head-band carrier—as shown in the cut. See, also, **Corneal loupe.**

Cornea, Sensibility of the. Especially for diagnostic purposes the degree of sensibility of the cornea is of importance. The normal cornea is very sensitive to contact, not only with the lids and especially the lid margins, but it becomes conscious of the presence of irritants of all kinds, whether they be mechanical, chemical or elemental.

The ordinary test of the corneal sensibility is gently touching the surface with a wisp of cotton-wool twisted to a fine point. If there is normal sensation contact should be instantly followed by (reflex) winking. As nictitation sometimes follows the approach of *any* object to the eye (owing to the patient *seeing* it in the pupillary field) the test-object should be applied with care to the periphery of the cornea.

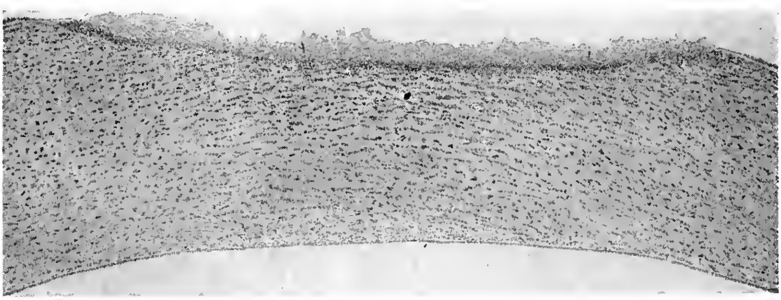
Leshure tests the corneal sensibility by projecting against the cornea a stream of air, drawn from the compressed air receiver through a rubber tube ½ mm. in diameter, and 2 mm. long, to give the necessary resistance. The air is controlled by a reducing diaphragm cut-off. With the air under pressure of five pounds in the receiver the stream is distinctly felt by the normal cornea. The cornea not perceiving this, should be considered anesthetic. Cerise has devised a corneal esthesiometer, in which a hair of the badger is used, and the amount of pressure employed is measured on a scale, the movement being transmitted through two wheels by which it is multiplied 250 times. A spiral spring returns the index to the zero point upon the scale. See *Ophthalmic Year-Book*, p. 20, 1909.

Verderame (*Ophthalmology*, July, 1913) found in 200 children, aged from one week to two years, that the sensibility of the cornea shows in the fourth month and becomes normal between the sixth and tenth months. This difference in the sensibility of the cornea between the newborn and adult can not be due to a difference in the structure of the nerves of the cornea, as the histologic examination of fifteen fresh corneæ of prematurely born and newborn children up to the age of one year showed them to have the same structure as those of adults. The difference must be attributed with great probability to the undeveloped function of the corresponding central nerve conduction. See **Cornea, Anesthesia of the**; as well as **Cornea, Reflex of the.**

Cornea, Serpent ulcer of the. Serpiginous ulcer. Septic ulcer of the cornea. Pneumococcus ulcer. Progressive ulcer of the cornea. Spreading ulcer. Hypopyon ulcer. Ulcus serpens. Sloughing ulcer of the cornea. Hypopyon keratitis. Suppurative keratitis. Creeping ulcer of the cornea. Under some one or more of the foregoing names this serious and important disease of the eye has for ages been well known. Roser in 1856 gave it the name *hypopyon*

keratitis. Saemisch in 1870, recognizing the characteristic creeping tendencies of hypopyon keratitis, assigned to it the name *ulcus serpens.* In 1887 Valdese published the first minute anatomical description of the affected parts. Horner was the first to study ulcus serpens microscopically, but to Uhthoff and Axenfeld belongs the credit of giving us (in 1896) an exact account of the pathological histology. Subsequently numerous other investigators contributed the results of their studies of certain histological details.

Serpiginous ulcer generally originates at, or near, the center of the cornea, in the form of a grayish-white or yellowish disc, surrounded by a delicate, gray area. It is frequently accompanied by gray striæ, radiating from the central portion of the ulceration. As the disease progresses, polymorphonuclear leucocytes collect between the corneal lamellæ and beyond the spreading margin, where they give rise to an infiltration, more dense and yellowish than the older portions of the

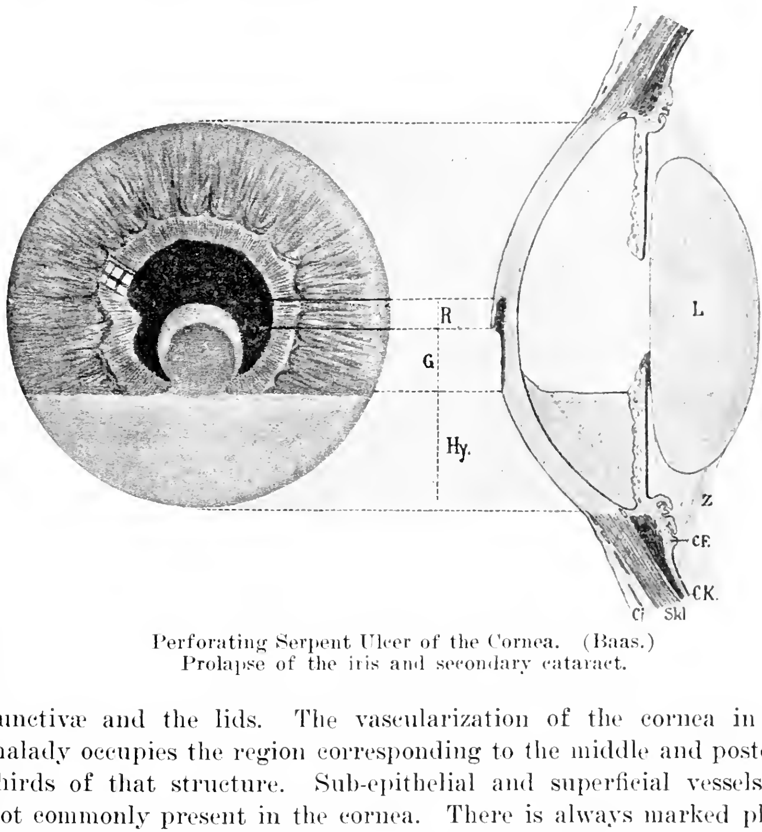


Serpent Ulcer of the Cornea. (Baas.)

ulcer. Ulcus serpens has a marked tendency to extend in one direction, a phenomenon of significant diagnostic value. At the beginning of this disease, numerous small dots are observed over the affected area; the epithelial layer is raised above the surrounding, normal corneal surface, a result of swelling of Bowman's membrane and the epithelial layer, superinduced by cell infiltration and proliferation. The elevated area is soon replaced by a sloughing depression with edges more or less sloping. Commonly, the entire area which has reached the ulcerative stage becomes uniformly clouded over, with the usual loss of lustre attending a corneal infiltration. Serpent ulcer develops superficially at the same time that the parts previously involved increase in depth. Its floor is bathed in heavy yellowish pus, beneath which the necrosis continues until perforation results. Glaucoma is an important factor in the causation of early perforation. Sometimes the sloughing is so extensive that the entire cornea is destroyed.

This disease is also characterized by early involvement of the iris, which becomes violently inflamed. The aqueous humor becomes turbid, hypopyon supervenes, posterior synechiæ form and an exudation membrane closes the pupil, thus completing a clinical picture which indicates the extreme virulence of the bacterial invasion and the malignancy of the case.

Except in the occasional torpid cases, the irritative and inflammatory symptoms are severe. Injection of the conjunctival and ciliary vessels is usually sufficiently intense to produce chemosis of the con-



Perforating Serpent Ulcer of the Cornea. (Baas.)
Prolapse of the iris and secondary cataract.

junctivæ and the lids. The vascularization of the cornea in this malady occupies the region corresponding to the middle and posterior thirds of that structure. Sub-epithelial and superficial vessels are not commonly present in the cornea. There is always marked photophobia and often intense, deep-seated ciliary pain. These symptoms are experienced in typical cases of this destructive disease. When perforation occurs, there is, of course, loss of aqueous and discharge of pus or other contents of the anterior chamber, and often prolapse of the iris. As generally happens after this accident, the irritative symptoms subside and the inflammatory signs abate. Occasionally, however, as a result of the entrance of pyogenic organisms, panoph-

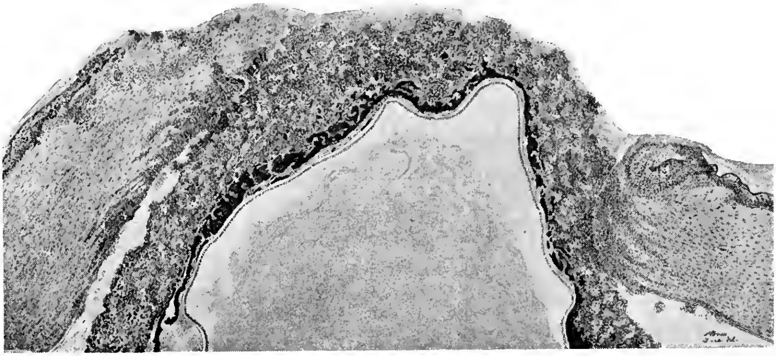
thalmitis develops, and entirely destroys the eye. The globe then contracts, producing a condition known as *phthisis bulbi.* In the absence of perforation, staphyloma, which is equally destructive to vision, is the condition most to be feared. The cicatrices of serpent ulcer are always dense.

Serpent ulcer is generally due, first of all, to an abrasion of the cornea, which is attacked by pyogenic organisms, usually the pneumococcus (Fraenkel-Weichselbaum capsulated diplobacillus), which

A B

Ulcus Serpens. (Ball.)

Appearance of the cornea. A, in the height of the disease. B, after treatment by Saemisch's incision.



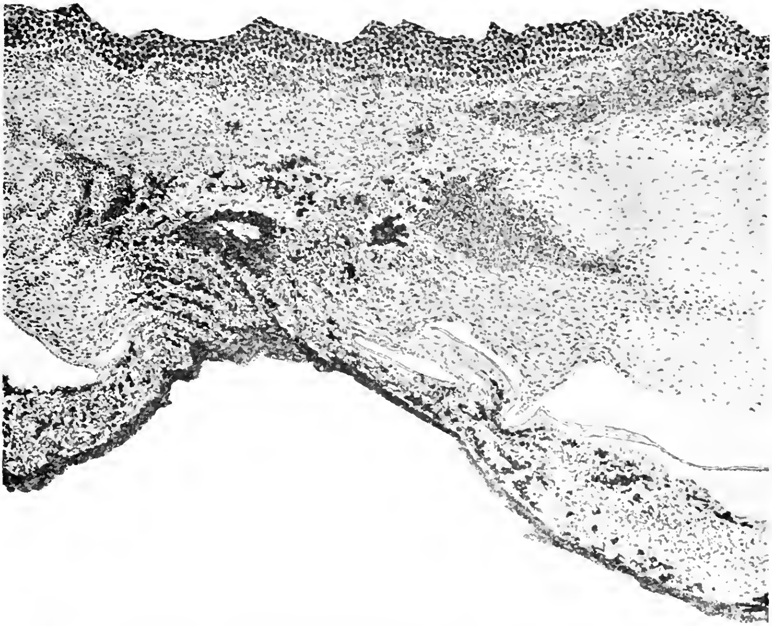
Clinical and Anatomical Picture of Serpent Ulcer of the Cornea.

(After Axenfeld-Elschnig.)

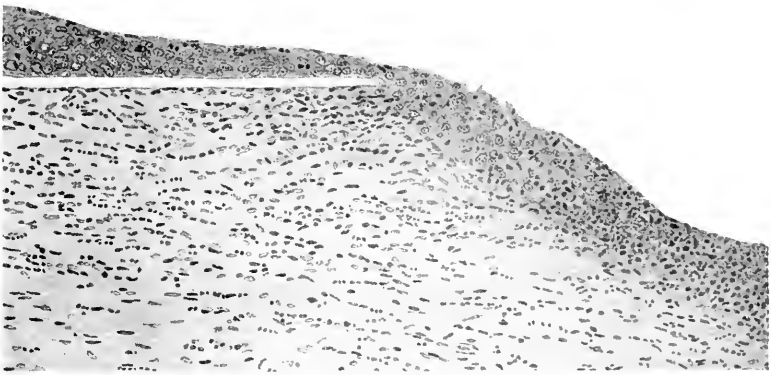
excites a purulent inflammation. Baudry states that the pneumococcus is the *only* pyogenic microbe found in this disease. Römer, Löwenstein and others have confirmed the findings of Uhthoff and Axenfeld with regard to the bacteriology of this corneal affection. Römer examined eighty cases of ulcus serpens and found the Fraenkel-Weichselbaum diplococcus in 95 per cent. Vasek, in forty out of forty-eight cases, which he examined bacteriologically, found the pneumococcus alone; in one, staphylococcus with sarcina; in one, the

bacillus liquefacians of Petit, and in another the bacillus of zur Nedden.

Next to the pneumococcus, the *diplobacillus of Morax-Axenfeld* is the bacterium most frequently responsible for the destructive infec-



Anterior Synechia Following Perforating Ulcer of the Cornea. (Baas.)

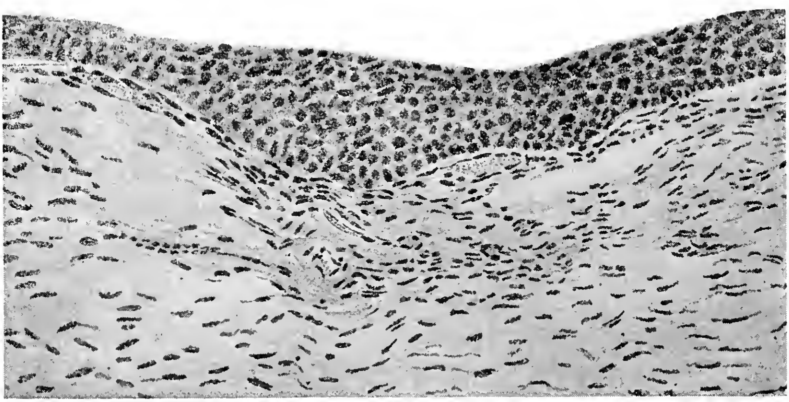


Serpent Ulcer of the Cornea in the Process of Repair, also showing Bacterial Deposits. (Baas.)

tion. In the absence of pneumococci the clinical picture of this microbic invasion frequently bears a striking similarity to typical (pneumococcus) ulcus serpens; not only in appearance, but in be-

havior. Numerous cases of hypopyon keratitis due to diplococcus infection have been reported by Paul, Weekers, Zade, Axenfeld, Erdmann and others and have, histologically, been carefully investigated, especially by Elschnig and Löwenstein. Clinically, it is quite impossible to distinguish between a Morax-Axenfeld and a typical (pneumococcus) ulcus serpens. We must, therefore, depend upon a microscopical study of individual cases for etiological information. A feature of the diplobacillus ulcer, to which Axenfeld attaches much importance, is the size and depth of the ulcer ground.

Zade reports twenty-seven cases of corneal ulcer due to diplobacillus infection in which there was no conjunctivitis or disease of the lachrymal sac. In this connection he mentions the probability of diplobacilli colonies vegetating in the conjunctival sac without caus-



Recent Scar of the Cornea, After Healing of Ulcer. (Baas.)

ing typical symptoms, but capable of producing severe corneal infection after a small lesion of the epithelium. He emphasizes a feature by which it may be distinguished from typical ulcus serpens, viz., the progressive margin of the diplobacillary ulcer is more superficial and has a peculiar, glassy appearance.

Rosenhauch succeeded in cultivating from the deposits of an ulcus serpens, a germ morphologically more resembling fungus than bacteria, which he named *keratophyton.* This was found pathogenic for the corneæ of guinea pigs and quite generally for mice. It is probable that the infection is never endogenous. In cases where there is no abrasion of the corneal epithelium, it (possibly) has its inception in injury of the peripheral nerves.

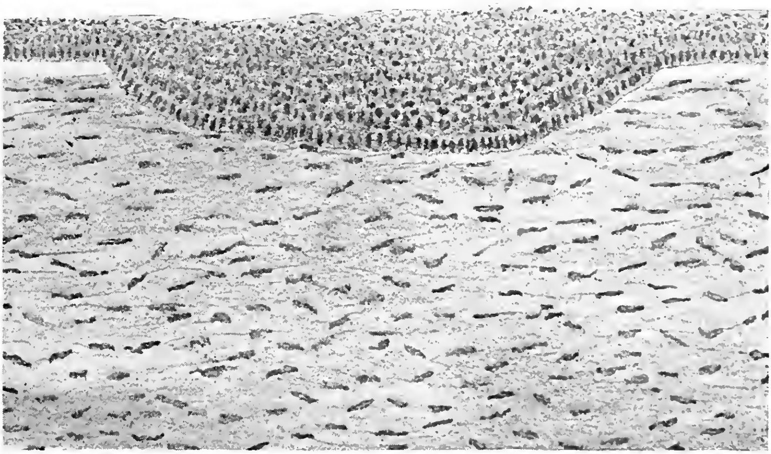
The microbic infection may be derived from the conjunctival sac, but, as a result of lachrymal obstruction and dacryocystitis, the origin

of the pus cocci is almost always the lachrymal sac, whence it regurgitates into the conjunctival sac.

Typical serpiginous ulceration rarely occurs before the fortieth year, but numerous cases have been observed at an earlier age.

Serpent ulcer is, for several reasons, usually found amongst the poorer classes and those exposed to various occupational injuries; in eyes previously diseased (especially affections of the conjunctiva and lachrymal sac) and in those suffering from malnutrition. It sometimes develops with measles, scarlet fever, typhoid, etc., but not commonly.

The micro-organisms are most numerous at the points of progress of the ulceration where the infiltration is dense and the polymorpho-



Epithelial Scar, After Repair of Corneal Ulcer. (Baas.)

nuclear leucocytes most numerous, while in the older areas few organisms are to be observed. In ulcus serpens the deeper corneal lamellæ remain free from invasion as long as Descemet's membrane continues intact.

In the exudate which covers the floor of the ulcer the existence of micro-organisms cannot always be determined. The infiltration of the superficial corneal lamellæ is the result of immigration of leucocytes from the limbus. The ulceration, as it progressively creeps between the corneal lamellæ, lifts them up, while the superficial layers are detached, thereby increasing the area of excavation. A fibrinous coagula between the lamellæ nearest the ulcer may be responsible, in some cases, for this separation. The middle lamellar layers suffer least from infiltration. As Descemet's membrane is approached, the

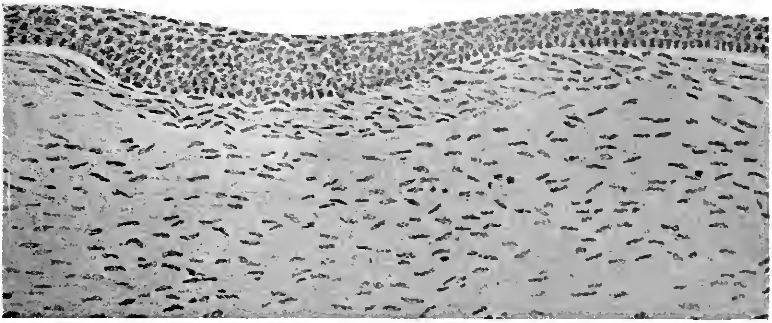
infiltration becomes pronounced, sometimes so intense as to form the so-called *posterior abscess,* which occupies a position corresponding to the ulcer proper. The origin of this posterior infiltration is a subject of dispute. Some authorities hold that the leucocytes are derived from the peripheral vessels and migrate inwards, while other investigators believe the opposite, that they are derived from the hypopyon, and travel forward. The latter theory, which seems more tenable, assumes a break in Descemet's membrane, which when intact is impervious to the passage of leucocytes. That Descemet's membrane is frequently involved, in the form of rifts or actual ruptures, has been well established, especially by Elschnig. The absence of the endothelial layer, corresponding to the situation of the ulcer, is frequently observed even when Descemet's membrane itself remains undisturbed.

Ulcus serpens, owing to its destructive nature, has always an unfavorable prognosis. Even in cases which terminate early, the vision is markedly lowered or permanently destroyed by the dense opacification, which is almost always located within the pupillary area of the cornea. In many cases, also, the whole eyeball is destroyed as the result of complications previously mentioned.

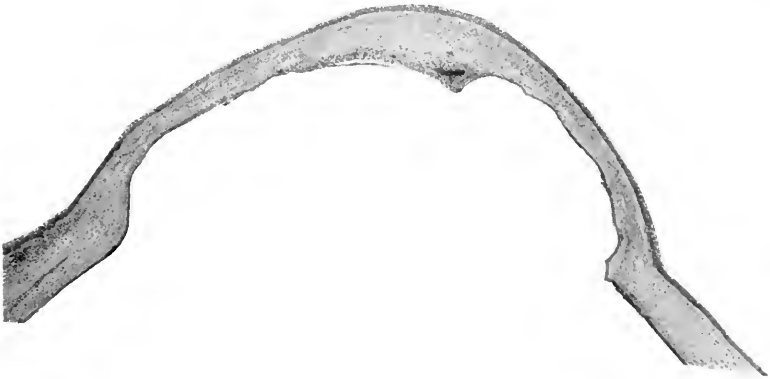
Treatment. In no other corneal disease is prompt and energetic treatment so requisite. Among the topical agents for direct application to the ulcer are iodoform, pyoktanin, nitric acid, phenic acid, peroxide of hydrogen, and tincture of iodine. There is no agreement among clinicians as regards the most efficacious remedy mentioned in the above list, but tincture of iodine seems to be generally popular. More recently, sulphate or chloride of zinc in 20 per cent. solution has been employed in keratitis with hypopyon (especially when the diplococcus is the responsible organism), with results so gratifying that some have come to regard it as almost a specific. Eperon, in a series of twenty-five cases, reports a successful termination of the infectious process, in nearly all cases, after a single application to the surface of the ulcer. The enthusiasm for subconjunctival injections has largely disappeared, yet injection of cyanide of mercury is held in high esteem by some observers. Atropine is generally recommended as a remedy to be employed early and frequently. With reference to the use of this drug, Schiötz states that in more than 50 per cent. of cases of ulcus serpens, the intraocular tension is increased, and that the use of atropine, by predisposing to glaucoma, may render the process more disastrous than when limited posterior synechia occur with the tension approaching normal. The use of the *actual or galvano-cautery,* preceded by holocain and fluorescin, is of the greatest

value. It is indicated in all forms and stages of the active disease and should be used thoroughly, especially to the edges of the ulcer. The condition of the lachrymal sac should always be determined and it should be promptly extirpated when blennorrhea is present.

When in hypopyon the pus (or exudate) in the anterior chamber reaches the border of the pupil, and it will not absorb, surgical intervention is demanded for its evacuation. The writer has found good



Old Leucoma of the Cornea, Following Repair of an Ulcer. (Baas.)



Partial Staphyloma of the Cornea, Following Ulcer. (Baas.)

results following *daily paracentesis*, a procedure which reduces the intraocular tension and counteracts the evil effects of atropine, thereby exerting a beneficial effect upon the ulcerative process without subjecting the eye to untoward influences. Many authorities believe that the Saemisch incision is the only alternative in severe cases, i. e., when perforation is imminent, the ulcer central, and hypopyon excessive. Other clinicians are less enthusiastic regarding this procedure than formerly. Fuchs recommends that the Saemisch incision should be

reopened daily with a blunt instrument until the ulcer shows that the destructive process has ended and healing has begun.

Römer's experiments with anti-pneumococcus serum as a treatment for serpent ulcer have attracted wide interest. It still remains *sub judice,* especially as regards dosage.

There is no operative treatment of spreading ulcer which compares with Kuhnt's conjunctivoplasty, that is, covering the ulcerating corneal surface with (bulbar) conjunctiva drawn over it, apron-like, and stitched to the opposite sclero-corneal margin. This procedure not only mechanically reinforces and protects the weakened cornea, but, in addition, provides the nutritive assistance so essential to the termination of this destructive disease.—(J. D. L.) See, also, **Cornea, Ulcer of the.**

Rosenhauch (*Ophth. Year-Book,* 1909) describes a new bacterial form which he found in ulcus serpens. It was a comparatively large, Gram-negative microbe; sometimes appearing as a thick rod, sometimes as a diplococcus. He is not able exactly to define its classification. In its growth upon agar it resembled the fungi. He gives it the name of keratophyte. It is easily killed by the sun's rays. Inoculation experiments show it to be pathogenic for animals.

Fuchs' (*Wien. Klin. Wochenschr.,* No. 1, 1909) investigations of serpent ulcer were pursued for the purpose of throwing some light upon the pathology of the early stages of the disease, and upon the question of its occurrence in children. As true ulcus serpens does not develop in the eyes of animals from infection with the pneumococcus, Fuchs inoculated the cornea of a human eye which was destined shortly to be enucleated. On the second day there appeared a small, white spot which was less saturated in the center than on the border; the third day the infiltration was no larger but the spot was more developed and had extended above the level of the surrounding cornea. At this stage the eye was enucleated. From the histological investigation it appears that not only is a lesion of the epithelium necessary, but also a tear of Bowman's membrane. From the pushing up of the surface of the membrane a pocket is formed and the development of the microbes causes a circumscribed necrosis. Around the necrotic plug there develops an infiltration presenting the picture of a white ring about a less cloudy center. If the necrotic plug is thrown off healing occurs, but if, as in the case experimented upon, the necrosis and infection invade in tongue-shaped form the surrounding structure, then the necrotic tissue remains to form the progressive border, which advances until all or most of the cornea has been destroyed.

Fuchs holds that typical ulcus serpens develops from an erosion

infected with the pneumococcus. The region of erosion becomes at first very cloudy, and then, about the second to the fourth day, infiltration gradually increases around its border, forming a small, gray ring. This ring later takes on a yellow color and pushes out into the clear, outlying tissue. Fuchs declares that the prognosis of ulcus serpens is always favorable if treatment is begun early, the majority healing without surgical intervention. Nine cases were seen in children, in all of which the pneumococcus was the cause. He finds that the infection of the cornea in children generally causes swelling. Only two cases took the form of ulcus serpens, the rest showed a puffy swelling elevated above the surface of the cornea, of a uniform gray or with the center more involved. The deeper cloudiness of the center is due to the accumulation of white cells at that point. Probably leucocyte migration goes on more rapidly than in adults on account of the greater activity of the leucocytes and because the distance to be traversed is less.

Zur Nedden (*Arch. of Ophthalm.*, p. 28, 1909), during many years of study of spreading ulcer, found but few cases of ulcus serpens caused by other organisms than the pneumococcus. Only one was found in which the Morax-Axenfeld bacillus was predominant. He suggests that as this bacillus is very commonly present in the eyes of the native of the Rhine region, there may have been an immunity established, so that it is here no longer pathogenic for the cornea. It certainly cannot be denied that in some countries it is more often the cause of this form of ulceration. He reports three cases showing the typical form and history of serpiginous ulcer, one caused by the streptococcus, the others by the bacillus subtilis. The hay bacillus has never before been reported as a cause of this affection. Analyzing the literature, he finds that true ulcus serpens may exceptionally be caused by the Petit bacillus, as reported by Macnab, the proteus bacillus seen by Krueger, the short and thick diplobacillus of Bach and Neumann, Friedlaender's pneumococcus observed by Gourfein, the diplobacillus of Morax-Axenfeld, the streptococcus, and the bacillus subtilis. In Paul's twenty-seven cases caused by the Morax-Axenfeld bacillus zur Nedden finds that seven presented a transient resemblance to ulcus serpens. In the atypical forms of hypopyon ulcer the bacterial forms most commonly seen are the diplobacillus and the bacillus of marginal ulcer. (*Oph. Year-Book*, 1910.)

Gallemaerts states that he believes it to be our duty to make a bacteriological analysis of all corneal ulcers and to base the treatment on the results; also that the term serpiginous ulcer can no longer be reserved alone for pneumococcus ulcer, since different microbes,

especially diplobacilli, can cause it. The term should always be completed by the designation of the microbic species which causes the keratitis.

In the treatment of serpent ulcer H. W. Woodruff strongly recommends subconjunctival injections of mercuric cyanide, after the method of Bourgeois: The conjunctiva is anesthetized by three or four instillations of four per cent. cocaine solution during ten or fifteen minutes. Then eight minims of a solution of cyanide of mercury, 1 to 1,000, with four minims of four per cent. cocaine added, are injected beneath the external conjunctival cul-de-sac with the hypodermic syringe. When the needle comes in contact with the external wall of the orbit the point should be turned slightly inward and the needle plunged deeply into the tissues, so that the injection is more than sub-conjunctival. The tissues of the orbit surrounding the eyeball are bathed with this solution. The swelling and edema which follow are quite severe, but this is probably beneficial rather than harmful. He has used these injections in thirty cases with signal success.

In most cases of infected ulcer, hospital treatment should be insisted upon. Beauvois (*Rec. d'Ophtalm.*, Dec., 1909) has seen many eyes lost from inefficient application of the remedies prescribed. He would have patients make three or four trips to the office daily, or enter the hospital if the home surroundings are not suitable. Nervousness or timidity of the attendant, or of the patient, prevents proper execution of instructions; ointments intended for the cul-de-sac are applied to the outside of the lids, and the eye-drops are used as lotions.

Baroggi (*Riv. Ital. di Ottal.*, August, 1908) touches septic wounds of the cornea with a one per cent. solution of perchloride of mercury. He finds it almost specific in such cases, having failed only in cases where treatment was delayed until the vitreous had suppurated. The cauterization leaves very little scar. Sclero-corneal wounds are less amenable to treatment than are the purely corneal ones. Vasek (*Zeitsch. f. Augenhlk.*, Dec., 1908) reports favorably of this form of cauterization, which he did in two cases of infected ulcer, by the Deyl hanging-drop method. He did not use a stronger concentration than 1 to 500, leaving the saturated cotton in contact with the bottom of the ulcer for one minute.

The reports regarding Roemer's serum are conflicting. Von Hippel and Vasek find it practically inert. As we cannot tell just what course the ulcer will next take, it is difficult to judge what effect any treatment has. Roemer makes a valuable suggestion that the virulence of the infection be verified upon the lower animals as a control experiment supplementing the clinical reports, because, as he has shown,

the pathogenic power of the pneumococcus varies widely. It is a pity that we have no ready means at hand to test this point before resorting to cauterization, which Axenfeld and Vasek pronounce the only sure remedy. Inoculation experiments upon animals would, of course, occupy valuable time.

Monbouyran (*La Clin., Ophtal.*, Jan., 1908) employed antidiphtheric serum in six cases of hypopyon keratitis, non-traumatic but complicated with dacryocystitis. Three injections sufficed to bring about a cure in most cases. The ulcers healed in from ten days to four weeks without perforation. He recommends the treatment, especially to provincial oculists treating farm laborers, who find it impossible to leave work to attend the clinic.

Vasek (*Zeitschr. f. Augenheilk.*, p. 520, 1908) reports in detail sixty-four cases of serpiginous ulcer systematically treated with galvano-cautery. Forty-eight of these were examined bacteriologically. In forty the pneumococcus was found, either alone or with the staphylococcus; in two the staphylococcus alone, in one the staphylococcus with sarcina, in one the bacterium liquefaciens of Petit, and in one the bacillus of Nedden.

His conclusions are: 1. The cauterization of serpiginous corneal ulcers is by far the most reliable means of arresting their progress. 2. The ulcer must be cauterized in the first few hours, if its progressive character is apparent, as then the cauterization is most reliable, but a correctly performed cauterization generally suffices in extended ulcers. 3. Any ulcer which commences to assume a serpiginous character must be considered as serious, as we are unable to determine from the clinical aspect the degree of virulence and the prognosis. 4. The cauterization must be especially thorough if the infiltration pervades all strata of the cornea or extends to the limbus. 5. The opening of the anterior chamber with the galvano-cautery has no advantage over the puncture with the lance-shaped knife. 6. In blennorrhea of the lachrymal sac this must be extirpated. 7. After extended cauterizations the patient must keep very quiet for some time, as perforation may take place as late as the third week.

Max Schnur (*Klin. Monatsbl. f. Augenheilk.*, Oct., Nov., 1913) has made some remarkable claims for ethylhydrocuprein chloride (AeHC) as a curative agent in ulcus serpens of pneumococcic origin. This remedy is a cinchona derivative and was suggested for spreading ulcer because of Morgenroth and Levy's (*Berlin. Klin. Wochenschr.*, No. 34, 1911) experiments with it against the pneumococcus. Schnur thus ends his first paper:

"The beneficial effect of ethylhydrocuprein on the course of ulcus

serpens corneæ due to pneumococcus infection will be immediately recognized from the details of cases. The remedy has also been employed in some instances where the smear cultures showed staphylococci and streptococci to be present in preponderating number. In these cases the action was far less prompt, progression being checked only after frequently-repeated applications of the remedy, which finally cured the trouble, slight recrudescences of which had from time to time been threatening. In these cases obviously the corrosive action of the preparation alone plays a certain part. This corrosive action may be taken as conclusively demonstrated from the formation of a false membrane in the conjunctiva in some of our cases.

"Sterilization does not in any way impair the efficacy of ethylhydrocuprein. In the beginning I employed a one per cent. watery solution of the hydrochlorate, but later on resorted to a two per cent. solution for the purpose of limiting the applications to the smallest possible number and shortest possible duration. Our first method of instillation into the conjunctival sac for the purpose of disinfection was subsequently abandoned because the slight pressure exercised by the well-soaked swab is sufficient to discharge enough liquid to irrigate the conjunctiva. The swab was brought into contact with the cornea so as to only just cover the ulcer. The use of the swab appears to me to be preferable to instillation, as it enables us in some degree to localize the action of the preparation and to favor penetration into the cornea by means of slight pressure. In neglected cases it proved a useful procedure to gently wipe away any deposits (but only in the ulcer area). AeHC, at least in a concentration up to two per cent., does not appear to penetrate through intact epithelium, or at any rate with much difficulty only; Ginsberg and Kaufmann (*Klin. Monatsbl. f. Augenheil.,* June, 1913) established by their experiments on animals that the preparation does not injure healthy corneal epithelium.

"It is advisable to prepare the AeHC solutions in small quantity only, and not to let them get too old; my experience is that freshly prepared solutions are the most active. Solutions, three weeks old, are already considerably less efficacious.

"The time of application of the swab was, after some experience, ended at the moment when a slight, grayish turbidity made its appearance in the immediate vicinity of the ulcer, showing that the preparation had penetrated into the cornea. It appeared to me that the action was the more favorable the earlier this turbidity occurred. On the other hand, the latter showed only after prolonged and repeated applications in severe cases so that we were often able to accurately foretell

the course the ulcer would follow, according to the prompt or delayed appearance of this turbidity.

"During the application of the swab, and for some time after, patients used to complain of a severe burning sensation, but this could be alleviated by a previous treatment with cocaine. The corneal anesthetization by the remedy, as established experimentally, was observed by me in three cases. A two per cent. solution produced anesthesia after 5 to 10 minutes, but it was generally not a total anesthesia and did not last long.

"As regards secondary effects, epithelial erosion in the immediate proximity of the ulcer occurred in some cases. I should further mention an occasional slight chemosis of the conjunctiva bulbi which, however, always disappeared rapidly. Superficial, scurfy membranes of the conjunctiva, similar to those following the application of weak silver solutions, soon became detached without the least injury to the conjunctiva. A more severe opacity of the cornea, due to the application of our solutions and their duration, has never been observed by me.

"I believe that our clinical experience proves AeHC to possess absolutely specific curative properties in ulcus corneæ serpens of pneumococcic origin without injurious secondary effects if applied in suitable solution and for the proper length of time. As far as we are able to judge after a relatively short period of observation, the scars seem to be much more delicate than those left from other methods of treatment, especially from cauterization.

"Since we began the AeHC treatment we have entirely abandoned galvano-cautery for pneumococcic ulcus serpens corneæ and no doubt we shall be able to do without it in the future."

Under the trade name of "optochin hydrochloride" this substance has been marketed by Zimmer & Co., Frankfort-on-the-Main.

Cornea, Simple ulcer of the. SUPERFICIAL ULCER. NON-PROGRESSIVE ULCER OF THE CORNEA. This rather indefinite term is intended to include all those forms of corneal ulcer that are not essentially progressive—serpiginous—and are yet the result of a traumatism and subsequent infection from without by the milder bacteria, or by weak invasions of more destructive germs. See, also, **Cornea, Ulcer of the.**

The infection may be furnished by and be secondary to a diseased condition of the conjunctiva, either confined to the palpebral or ocular portion or affecting both. Although this form of ulcer may extend into the cornea proper its tendency is to heal without further loss of substance.

In the milder forms of the disease the pure tincture of iodine has

a beneficial effect. Pure carbolic acid, 10 per cent. solution of nitric acid, iodized phenol, 1 in 20 of formalin, or 1 per cent. solution of sublimate in alcohol, have all been used with good results.

A wooden tooth-pick is dipped in any of these remedies and applied thoroughly to the cocainized ulcer-excavation, after cleansing and staining with fluorescein. To be effective the tooth-pick should be soaked in the germicide fluid and pricked into the surface of the ulcer.

R. L. Randolph sees a great many cases of foreign body in the cornea of railroad men from the shops. Generally the foreign substance is either a particle of rust or a minute piece of emery. When he sees the patient the foreign body has generally been picked at and an infected ulcer is present. When every trace of the extraneous substance has been removed he finds this collyrium most soothing and antiseptic: Holocain, gr. ss; sod. chlor., gr. iii; aquæ dest., f. ℥ii.

A small quantity is given, for healing usually takes place in from twenty-four to forty-eight hours.

If the ulcer be small and there is difficulty in its detection a drop of two per cent. solution of fluorescein will immediately reveal its locality and extent. If it be large enough to be readily seen it will have a slightly scooped-out appearance with a grayish floor and a circumference surrounded by infiltration. There will be more or less circumcorneal congestion whose extent will depend in a great measure upon the situation and extent of the ulcer. It will then be attended by pain more or less severe, photophobia, blepharospasm and lachrymation, while the pupil will be slightly contracted. When it undergoes repair the depression fills up with new tissue which soon becomes covered with epithelium, leaving a whitish scar. The opacity becomes less dense, as time goes on, and in some instances disappears entirely.

One drop of 1 per cent. solution of atropin sulphate should be instilled into the conjunctival sac at once and continued once or twice daily or often enough to keep the pupil dilated.

The application of hot water (as hot as can be borne) should be kept up every one to three hours, depending upon the amount of inflammation and pain present. This should be followed by washing out the conjunctival sac with a mild antiseptic lotion: boric acid solution, 3 per cent.; solution hydrarg. bichlorid, 1 to 10,000; solution permanganate of potassium, 1 to 4,000, etc.

The eye should not be bandaged, but covered with an eye-shade, a piece of sterilized gauze being placed between the eye and the shade. The cornea and conjunctival sac should be carefully examined, foreign bodies should be removed and diseased lids treated with appropriate

remedies. Tonics and other proper remedies should be given when the general health is at fault.

De Wecker believed that when properly carried out there is no remedy in all forms of corneal ulcer equal to subconjunctival injections. The eyelashes and lid-edges are first scrubbed with a 1 to 100 solution of oxycyanide of mercury and the eye thoroughly irrigated with a saturated (4 per cent.) solution of boric acid. The eye is then cocainized and fifteen drops of the following is to be injected beneath the conjunctiva, as near the ulcer as possible: Hydrarg. bichlor., gr. 1/4 (0.015); eserin. salicylatis, gr. i (0.05); aquæ dest., fl. ℥iiiss (100.00).

This should be repeated daily if required, but the dose ought to be diminished when improvement is noticed. The injection should be followed by a bandage.

If iritis be present scopolamine should be substituted for the eserine.

Albert R. Baker advised a routine treatment of ulcer of the cornea somewhat different from that of most ophthalmologists. At the same time the plan struck him as rational. Upon the first visit the patient is directed to bathe the eye in hot water for half an hour. Then the cornea is stained with fluorescein. Now, with a piece of cotton tightly wrapped around the end of a wooden tooth-pick and dipped in a 1 to 250 solution of mercuric bichloride, it is applied to the ulcer with a sort of rolling motion between the fingers until the fluorescein stain entirely disappears. Cocain or eucain may be used to render this act painless. Then atropia is instilled and the whole eye subsequently dusted with fine boric acid powder. A compress is applied to both eyes. This treatment may be given daily until a cure is brought about.

A. E. Prince has long used with success a 10 per cent. solution of salicylic acid in alcohol as an application to small corneal ulcerations.

The Editor has used iodine trichloride (q. v.) in its pure form as a cauterant in the simpler forms of corneal ulcer and if the preliminary cleansing and other accessory precautions in the treatment of this disease are regarded he believes it to be a reliable agent for the purpose.

After scarifying the blood-vessels about the corneal margin in superficial ulcer Webster Fox (*Text-book*, p. 157) advises the use of the following formula: Daturin, sulph., gr. ss; acidi boracici, gr. vj.; acidi carbolic, m. j; aquæ dest., fl. ℥j.

Five drops into the eye four times daily.

Dolganoff claims that in corneal ulcer subconjunctival injections of parachlorophenol (1 per cent. in water) are quite as effective as mercuric cyanide or bichloride and not nearly so irritating and pain-

ful. The phenol compound really acts as an analgesic and the discomfort following the injection is small or lasts only a few minutes.

A very effective cautery for corneal ulcer is a 30 per cent. solution of lactic acid. After staining and cocainizing the affected cornea a pointed, wooden tooth-pick is dipped into the fluid and thoroughly but carefully applied to the diseased area. A small slough separates in a few days.

Similar results are obtained by the application of a few crystals of sozoiodolate of zinc.

C. M. Hobby advises as a cauterant a 95 per cent. alcoholic solution of iodine (saturated) into which an equal amount of crystals of phenol has been placed. This mixture is carefully applied with a tooth-pick to the ulcerating surface. He prefers it to the electric cautery because, in his hands, he has been able to limit its effects better than he can the cautery or any other agent.

Iodized carbolic acid or solution of iodine in glycerine-carbolic acid is one of the preparations of the *National Formulary*. Applied pure to corneal ulcers it is one of the best cauterants and germicides we possess. The Editor believes it to be in that respect even better than pure tincture of iodine or pure phenol used alone. Of course, it is to be carefully rubbed into the stained, cleansed and cocainized cornea by means of a pointed tooth-pick or wooden match soaked in the fluid.

As a caustic application to corneal ulcer chromic acid is also of considerable value. The acid, fused on the tip of a silver probe, should be carefully applied to the cocainized eye so as to destroy as little as possible of the healthy tissues. The ulcer must be previously stained with fluorescein and afterwards gently irrigated with a 2 per cent. sodium chloride solution.

Trichloracetic acid is an effective cauterizing agent for corneal ulcers, to be applied pure on the end of a wooden tooth-pick, or match soaked in it, any excess of acid to be removed from the applicator before the cautery is begun. The trichloracetic acid application should be carefully made. D. H. Coover advises the use of a 10 to 25 per cent. solution once daily. The eye should be anesthetized and the application made with a tooth-pick directly to the ulcerated area, hot fomentations being applied frequently to relieve pain.

C. D. Cadwell prescribes in corneal ulcer due to the diplobacillus: Ammonio.-ichthyol., 0.15; zinc. oxid., 5.00; vaselin. alb., 15.0, to be thoroughly mixed and applied both to the inside and outside of the lids.

James A. Spalding finds that an ulcer that does not yield to the local application of tincture of iodine, carbolic acid or the cautery may be

cured by the use of the following: Zinci sulphat., 0.12; aquæ dest., 30.00. A drop or two to be applied directly to the ulcer with a cotton-tipped probe, or it may be used as an ordinary collyrium once or twice a day. Many people dread caustics and cauteries and as a substitute this lotion is of value.

In intractable, superficial ulcer Webster Fox (*Text-book,* p. 157) has found subconjunctival injections of great value. He uses the following formula: Sodii saccharat., gr. xv; aquæ dest., fl. ℥i.

Chandler and Risley have reported favorably on the use of a 10 per cent. ointment of casseripe in the treatment of corneal ulcer. Although distinctly antiseptic, it may be freely rubbed into the conjunctival folds two or three times a day, the application to be followed by boric acid lotion and a pressure bandage.

F. A. Morrison prefers the following formula as a dusting powder, to be followed by the use of a compress for a short time: Argyrol., 3ss.; pulv. acaciæ, ℥iiss.

Alexander Randall and J. A. Lippincott find that boiling hot water dropped slowly from a fine pipette on the ulcerating surface removes only dead tissue, meantime stimulating the living margins without injury to them.

Norton L. Wilson regards the following application, to be applied directly to the ulcer, of great benefit and thinks that no other is more effective except, perhaps, the galvano cautery: Tinct. iodi; phenol. glycerini, āā 3i.

A. Barkan is much in favor of cauterizing the ulcer with the blunt end of a steel strabismus hook, heated in the flame of an ordinary alcohol lamp to a cherry-red heat. He touches the cocainized corneal ulcer with it quickly and rather forcibly so as to form a distinct though superficial eschar. The hook cools off immediately, although it burns thoroughly. This simple and safe proceeding may be repeated several times until the whole infected area is covered. The parts are then dusted with finely powdered iodoform, and a bandage is applied for twenty-four hours. This procedure, as is well known, was suggested by Gayet over twenty-five years ago.

G. C. Savage advises in corneal ulcer the use of one drop of acetic acid in five or seven drops of water once in twenty-four hours. His method of applying is to touch the ulcer gently with a piece of absorbent cotton wrapped round a tooth-pick, saturated with the above solution. The advantage of acetic acid over other agents is that while it destroys germs, as the other agents do, it does not destroy cell life, connective tissue, nor the epithelium.

J. F. Clarke applies tincture of iodine to all forms of simple corneal

ulcer and finds it acts promptly. (Wood's *System of Ophthalmic Therapeutics*, p. 724.)

In the *Ophthalmic Year-Book* for 1912-13 may be seen the following abstracts:

Von Reuss (*Ophthalmoscope*, p. 352, 1911) obtains a kind of double staining of corneal ulcers by following the use of fluorescein with an instillation of a 1 per cent. solution of methylene-blue. Treated in this way ulcers appear blue, with a greenish border, but defects covered imperfectly appear very green. Darier (*Clin. Ophtal.*, p. 2, 1911) urges that fluorescein should be more generally used for diagnostic purposes. He has found scarlet-red of great benefit in corneal wounds and infected ulcers, dendritic keratitis, etc.

The observations of Morax regarding a form of superficial ulcer with miosis not overcome by atropin, are confirmed by Bronner (*Tr. Oph. Soc. U. K.*, p. 97, 1911), who reports three cases of this kind. The patients were men twenty-six to fifty-six years of age, who complained of severe pain and photophobia, that were not relieved by applications of carbolic acid, galvano-cautery, etc., and atropin had failed to dilate the pupil. The ulcers were superficial and not infiltrated. After prolonged treatment of six weeks to three months had failed to give relief, Bronner did iridectomy. The following day the patient was free from pain, and the ulcer healed rapidly in each case. He suggests that in these cases there may be neuritis of the nerve endings in the cornea, provoking a reflex spasm of the sphincter of the pupil, which may in turn prevent healing.

The use of radium for corneal ulcer and for acute non-ulcerative inflammation, is reported by Lawson and Davidson (*British Med. Jour.*, Nov. 12, 1911) with gratifying results. Watson (*Ophthal. Record*, p. 256, 1911) has applied trichloracetic acid in 5 to 25 per cent. solutions, and finds it better than the thermo-cautery, because it destroys less tissue. One to twenty-four hours after the application the haziness has cleared up. Cornwall (*Ophthalmology*, p. 237, 1911) has used electrolysis in the treatment of indolent ulcers of the cornea.

Nance (*Jour. Oph. and Otol.*, p. 325, 1911) has found scarlet-red a safe therapeutic agent of value, accelerating the regeneration of the corneal stroma, and encouraging cicatrization, especially in the deep ulcers. It appears to possess no antiseptic properties. He uses it in a 10 per cent. ointment, which is not irritating. Wyler (*Ophthal. Record*, p. 60, 1911), following the teachings of Kaufmann, has found that for recurring superficial ulcers of the cornea the greatest benefit was obtained by scraping away with a spatula all loose epithelium, and rubbing the surface with a cotton-wrapped probe soaked in 3 per

cent. chlorin water. To ascertain the full extent of the diseased tissue a second staining with fluorescein should follow the first removal of the epithelium.

Cornea, Sloughing of the. Owing to drying of the corneal surface (through infrequent winking and widening of the palpebral fissure) the epithelium is easily removed; infection follows and ulceration results with sloughing sufficient to destroy the eye. Sometimes, in these cases, vessels develop in the lower part of the cornea. Slight anesthesia of the cornea is often present. In severe types of exophthalmic goitre, after removal of the Gasserian ganglion, in paralysis of the orbicularis, total staphyloma and, in some other conditions, long-continued exposure of the cornea may bring about this serious condition.—(J. D. L.)

Corneal suppuration in Basedow's disease led to complete blindness in a case seen by von Poppen (*Deutsch. Med. Wochenschr.*, p. 2002, 1910). Each eye became dislocated and strangulated in the palpebral fissure. Blindness resulted in spite of canthotomy and covering the cornea with a conjunctival flap.

Cornea, Sloughing ulcer of the. See **Cornea, Serpent ulcer of the.**

Cornea, Spincteralgic ulcer of the. This title is applied by Morax (*Bull. de la Soc. Frs d'Ophtal.*, 1911) to a special type of corneal ulceration. With superficial corneal ulceration there is persistent strong contraction of the pupil which does not yield to instillations of atropin, and is attended with violent pain. In such cases continuing several weeks he did iridectomy, bringing about relief from pain and healing of the ulcer. The portion of iris removed showed no inflammatory lesions. He compares the condition with anal fissure, which is cured by dilation of the sphincter.

Cornea, Spreading ulcer of the. See **Cornea, Serpent ulcer of the.**

Cornea, Staphyloma of the. Keratectasia. In this affection, the cornea becomes protuberant (ectatic), often from a prolapse of the iris due to perforation and extensive destruction of corneal tissue. The resulting cicatrix is chiefly composed of iridic and scar tissue, which has replaced the cornea. Staphyloma is either *partial*, or *total;* and, in shape, either *conic* or *spheric*.

Partial staphylomata are usually also conical. In most cases they extend towards the limbus, where, as indicated by the distorted pupil, partial prolapse of the iris has occurred. The cone is at first grayish-white, later, almost pure white, while the remaining portion of the cornea may show little or no loss of transparency.

When the entire cornea has been replaced by a protuberant cicatrix and a complete prolapse of the iris has occurred, the condition is termed

total staphyloma. The bulging extends to the periphery of the cornea or even beyond, and may involve the ciliary region. Keratoglobus sometimes follows, with a hernia so protuberant that it cannot be covered by the lids. As a result, dryness of the corneal epithelium is induced and a process of keratinization develops, sometimes followed by horn-like incrustations when these dried cells are not removed, or an ulceration may complicate the staphyloma, especially in cases where protection of the lids is lacking and the normal supply of moisture to the cornea has been suspended. Total staphyloma means that the ulceration and corneal destruction have been extensive, such as, for example, sometimes follows ophthalmia neonatorum. In *staphyloma racemosum* the bulging is lobulated, occurring as a consequence of multiple perforations; between the lobules there are strong constricting bands.

In the formative stages, the most protuberant part of a staphyloma is grayish; later, it becomes quite white or slate-colored. The discoloration is due to localized thinning of the cicatrix, or to the pigment of the iris deposited therein. In some cases calcareous deposits are present. One or more rather large vessels from the conjunctival plexus are commonly observed traversing the surface of the staphyloma.

It is probable that every case of staphyloma, whether partial or total, is accompanied by more or less increase in intra-ocular tension. This is due, first, to the irritation of the adherent iris (which results in excessive secretion of aqueous humor), and, second, interference with the escape of the aqueous by closure of Fontana's spaces. *Primary protrusion* occurs as a result of perforation, when the iris prolapses and bulges forward, being unable to resist even the force of normal intraocular pressure. The prolapsed iris heals in the scar and these together fill in the perforation. *Secondary protrusion* develops subsequent to the healing of the prolapsed iris, and ends in a flat cicatrix with bulging, which varies in extent and contour.

Fuchs believes that in individual cases a primary and secondary protrusion can not always be sharply differentiated. A very frequent case is that in which the iris, being extensively prolapsed, is protruded from the start; the intraocular pressure in this case being at first normal and afterwards gradually rising, so that the protrusion then increases still more.

A staphyloma, accordingly, in its origin is not a bulging of the corneal tissue, but of the iris. It develops from a prolapse of the iris, which is converted into cicatricial tissue, that is, develops just at the spot where the cornea no longer exists. It would therefore be more

correct to speak of staphyloma iridis. In fact, the transition from prolapse of iris to staphyloma is altogether gradual, so that at a certain stage of its development the protrusion in the eye may be equally well denoted as an old prolapse of the iris or as a recent staphyloma.

The findings noted by Parsons (*Pathology of the Eye,* Vol. I, p. 168) are as follows: "In the earliest stage there is merely a prolapsed iris covered with exudate, which also fills the pupil. The iris is acutely inflamed and densely infiltrated with leucocytes. Granulation tissue forms upon this surface, often in large masses, which may contain iris pigment, etc., and remnants of the lens capsule and lens, if this has been expelled from the eye. Epithelium grows over this granulating surface, filling the crevices and developing at first irregularly, as in all such conditions. The granulation tissue gradually develops into scar tissue in the usual manner, which need not be recapitulated. The iris stroma is only apparent in the early stages; it slowly atrophies, and usually becomes entirely replaced by fibrous tissue. The uveal pigment persists, at first as a well-defined layer. Later it becomes broken up; cells or clumps of pigment or isolated granules are found scattered in the scar, but the main part lines the staphyloma. As this stretches the pigment layer atrophies in parts, and the remainder becomes transformed into a network, which varies greatly in different cases.

"The thickness of the staphyloma depends chiefly on the amount of scar tissue, though the epithelium also differs in this respect. It may be as thin as paper, and is not often thicker than the normal cornea. The epithelium may grow directly on the prolapsed iris, the granulation tissue being reduced to a minimum. Often Descemet's membrane is prolapsed and convoluted, and I have seen the epithelium growing upon this, filling in all the convolutions.

"The epithelium is usually very thick, often showing downgrowths or forming true papillæ. There are sometimes epithelial nests, and prickle-cells are generally developed in the middle layers. It frequently becomes typically epidermoid; keratohyalin granules form in the upper layers, staining deeply with hematoxylin or by Gram's method, whilst the surface layers lose their nuclei and become horny. Various degenerative changes occur in the epithelium, especially over calcareous deposits, and atheromatous ulcers occur in these eyes. Spaces form in the epithelium, separated by thin walls of shrunken cells; they are formed between the cells and not by vacuolation, and are often covered by a single layer of epithelium only.

"The scar tissue consists of very dense fibrous tissue, with few cells

and few vessels. Pigment is found here and there, and calcareous deposits often occur. Sometimes the fibrous tissue shows hyaline degeneration, and masses of hyaline or granular material may replace the superficial layers. The hyaline deposits may occur as granules, globules and concretions, or great masses and whorls of hyaline fibrous tissue may be found. The thickness varies much in different parts, owing to the bands which project upon the posterior surface. At the extreme periphery remnants of Bowman's and Descemet's membranes may be found.

"Sachsalber found large numbers of elastic-tissue fibres in the sclera, episclera, peripheral part of the cornea, and to a less extent in the conjunctiva in cases of anterior staphyloma. These form fine, very wavy fibres, which stain deeply with eosin; they increase in length and breadth, become spiral and irregular in thickness, and finally break up into hyaline granules and clumps. The condition is allied to that found in pinguecula.

"In some of the hyaline deposits in anterior staphyloma Beselin obtained a typical amyloid reaction with iodine and iodine violet, whereas with gentian violet and methyl violet the reaction was inconclusive. There is therefore the same uncertainty about the chemical nature of the deposits in this situation as in the conjunctiva and elsewhere.

"Schiele, using the iodine test, found glycogen present in the epithelium, in newly formed connective tissue, and in the corneal corpuscles.

"The anterior chamber is obliterated, whilst the posterior chamber is enormously enlarged. The ciliary body is usually atrophic, owing to the rise of tension, and the ciliary processes are dragged inwards and elongated by the fibres of the zonule of Zinn. The lens is often absent, having been expelled when the perforation occurred. In other cases it is cataractous and shrunken; frequently it shows an anterior capsular or a pyramidal cataract. It is often subluxated. The other parts of the eye show changes dependent chiefly upon the secondary glaucoma.

"The fluid contained in the posterior chamber differs from normal aqueous. It is generally yellow, rich in proteids, and capable of coagulating. It often contains cholesterin crystals, blood, etc."

The effect of the formation of staphyloma on vision varies with the position of the pupil and the condition of the cornea not involved in the ectasia. The eyesight is always more or less impaired and in total staphyloma the loss is almost complete; ultimately, as a result of increased intraocular tension, vision is entirely destroyed. Even in

cases that terminate favorably, there is considerable reduction of vision, caused by alteration of the corneal curvature, which produces an irregular astigmatism. Staphylomatous thinning and protrusion may continue to increase and, in some cases, the sclera, adjacent to the cornea, participates in the ectatic process. Still, stretching of the sclerotic does not, owing to its toughness, occur except as a result of prolonged hypertension, and then mostly in young subjects whose scleral tissues are considerably softer and more tensile than in adults.

The disfigurement due to large staphylomata is most marked; and it becomes more and more conspicuous as the protrusion increases. As a result of the excessive thinning of the eye coats in total staphyloma, rupture is easily induced. When this accident occurs, it is frequently followed by intraocular hemorrhage, irido-cyclitis or panophthalmitis. Whether or not the eye escapes these sequelæ of rupture, atrophy is the ultimate fate of the eyeball.

Treatment. Aside from operative measures, little can be accomplished in the treatment of staphyloma. When prolapse of the iris occurs, every effort should be made to prevent the development of staphyloma by such means as promote a flat cicatrix. Rest must be insisted upon. A pressure bandage is advisable to support the weakened cornea. It is imperative, in cases predisposed to staphyloma, that any occupation which occasions fatigue, such as manual labor, or any act accompanied by straining, should be strictly avoided, because these are pronounced factors in the development of this affection. Pontius (*Annals of Ophthalm.*, Oct., 1912) reports six cases of acute staphyloma in which the use of 1:1000 epinephrine, instilled three times a day, was followed in each instance by satisfactory results. Others have confirmed this claim.—(J. D. L.)

An excellent result in a case of leucomatous staphyloma of the cornea in a child, aged nine months, was obtained by Wicherkiewicz (*Klin. Monatsbl. f. Augen.*, 1906). The staphyloma was punctured with a Bowman's needle and the aqueous emptied in a stream. The protrusion, now collapsed in folds, was grasped with forceps, and an oval piece, almost of the width of the cornea and 4 to 6 mm. high, was cut off with scissors. The wound-edges were accurately adapted and healed without sutures. Tension became normal and three months later the eye had the same size as its fellow.

In a case of recent destruction of the cornea, increased tension and large staphyloma in a girl nine years old, Coppez (*Soc. Belge d'Ophtal.*, p. 29, 1911) did trephining in the scleral margin with very satisfactory result. The staphyloma disappeared and tension was normal three months later. Komoto (*Ophthalmology*, p. 597, 1911) operates on

corneal staphyloma by transfixing with a Graefe knife, excising as much tissue as necessary with scissors and bringing the parts together with three sutures, as indicated in the figures.

Attias (*Oph. Year-Book*, p. 137, 1913) transfixes the staphyloma horizontally at its base with a Graefe knife and divides the corneal tissues along the horizontal line between the puncture and counter-puncture. Two silk sutures are passed obliquely, their points of entrance and exit lying about 3 mm. within the limbus, one passing from the upper-outer to the lower-inner quadrant, and the other from the upper-inner to the lower-outer quadrant. With the de Wecker scissors, a star-shaped figure is excised from the cornea, the four points of the star consisting of isosceles triangles, whose apices are

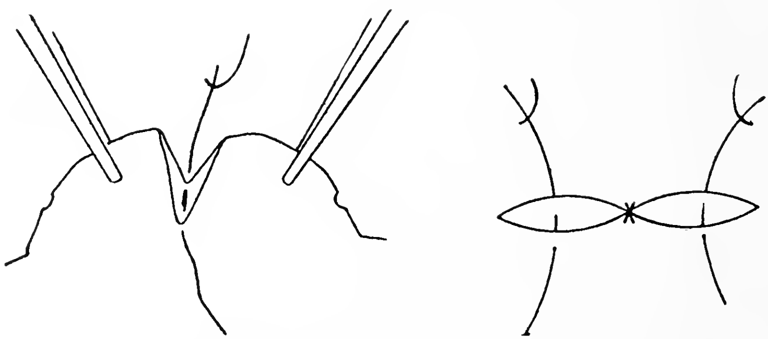


Fig. 1.—Komoto's Operation for Anterior Staphyloma. After excision of tissue the central suture is introduced.
Fig. 2.—Central Suture Tied, other Sutures Placed.

at the corneal periphery above, below and to the nasal and temporal sides. The broad angular flaps lying between these points are now brought together by means of the two sutures. After dusting the eye with iodoform or xeroform, a binocular bandage is applied. The threads are removed on the third day.

Samuels (*Arch. of Ophthalm.*, Vol. 42, p. 12, 1912) excised a staphyloma involving three-fourths of the cornea, and sutured the scleral edges. Three years later the space formerly occupied by the eyeball was replaced by a cyst-like body, which, when removed and examined microscopically, showed a cyst lined with epithelium which entirely surrounded the shrunken globe. He regarded it as an implantation cyst due to inaccurate conjunctival approximation, against which he sounds a warning.

Cornea, Striate opacity of the. This form of opacity following cataract operation is described by Hulen (*Trans. Section Ophthalm.*,

A. M. A., 1909). Observers are generally agreed that this condition is due to injury done to Descemet's membrane in the delivery of the lens. Such damage is more likely to ensue if the corneal incision is too small. The direct cause of the opacity is the penetration of the aqueous into the corneal stroma. Some of the earlier published cases may have been caused by the use of too strong antiseptics. See **Keratitis, Ribbon-like.**

Cornea, Subepithelial plexus of the. This nerve-plexus supplies (and breaks into fine filaments beneath) the anterior epithelium of the cornea.

Cornea, Supporting fibres of the. FIBRÆ ARCUATÆ. These are curved bands extending throughout the substance of the cornea. They are simply unusually oblique, interlacing bundles of fibrous tissue, and are not independent structures.

Cornea, Suppurative ulcer of the. See **Cornea, Serpent ulcer of the.**

Cornea, Symblepharon of the. Organic union between the cornea and the palpebral conjunctiva, or other lid tissues, is rare and, when it occurs, follows ulcer of one or both organs, or is the result of trauma. Brückner (*Zeitschr. f. Augenhlk.*, p. 505, 1912) reports three cases which, with two similar cases detailed by Saemisch, show that corneal ulcers may lead to adhesions to corresponding areas in the palpebral conjunctiva, especially if the latter have an epithelial defect, and if the adherent parts are immobilized. This may be brought about by protrusion of the globe, *e. g.*, from inflammatory diseases of the orbit, swelling and spasm of the lids, entailing permanent closure of the lids. One of Brückner's cases demonstrated that even the immobilization of the eye and lids during a night's sleep may terminate in symblepharon. Therefore the operative treatment of these forms of symblepharon is generally easy. The surgical separation of the bridge suffices, since the movements of the eyeball and lids prevent a recurrence. A transplantation of conjunctiva to the wound surfaces will be necessary in exceptional cases.

Cornea, Symmetrical opacity of the. ZONULAR OPACITY OF THE CORNEA. BAND- OR RIBBON-SHAPED OPACITY. TRANSVERSE FILM. See **Band-shaped keratitis,** Vol. II, p. 877, of this *Encyclopedia*.

Cornea tabefacta. (L.) Atrophy of the cornea.

Cornea, Tattooing the. Tattooing of the cornea is a useful procedure for the improvement of the appearance of the eye in cases of corneal leucomata. It is also valuable where there are superficial opacities of the cornea that are situated in the pupillary area, doing away with visual disturbances that are produced by dispersion of light while passing through the translucent area. Grandelément (*Lyon*

médical, 2nd March, 1891) speaks highly of the method as a curative measure in conical cornea. Gayet (*Lyon médical,* 2nd March, 1891) thinks that the happy result obtained in Grandclément's case was due rather to the scarification practiced than to the tattooing. Nagoya (*Beiträge zur Augenheilkunde,* 1905, pt. 64, p. 232) has proved by experiment and by quite a number of cases, that improved optical and visual results can be obtained by the tattooing of translucent corneal areas with India ink. It has been found useful in albinism, aniridia, and coloboma of the iris. At times, the material has been placed in the transparent cornea in order to lessen any undue dispersion of light which has been produced by too extensive an iridectomy. In all of these latter cases, the area opposite the pupillary space should not be disturbed.

The operation, for cosmetic purposes, goes as far back as the time of Galen, who attempted to conceal such opacities by the use of ferric tannate and mixtures of powdered pomegranate bark and a salt of copper (*Traité des Maladies des Yeux,* 1894, Vol. I, p. 274). In 1868, Anagnostakis (*Annales d'Oculistique,* LXVIII, p. 126) spoke of the plan as having been adopted by the Greeks. Hirschberg (*Deutsche medicinische Wochenschrift,* 1891, No. XXX) gives an interesting historical account of the procedure.

In 1870, the method was brought into vogue, particularly by Abadie and de Wecker (*Union médicale,* 1870, March): de Wecker made his first attempt in his clinic in 1869 (*Ocular Therapeutics,* 1879, p. 147). Reuss (*Wiener medizinische Presse,* 1871, p. 945) also speaks of the plan. Two years later, an excellent paper upon the subject was contributed by Ravà (*Del tatuaggio della cornea,* 1872, p. 32). The same year Dunnage (*Medical Times and Gazette,* 1872, I, p. 619) and Ticehurst (*The Lancet,* 1872, I, p. 619) gave good accounts of the method. Levis (*Phila. Medical Times,* 1872, p. 4) and Woinow (*Sitzungberichte der Gesselschaft russischer Aerzete,* 1872, No. 13) made mention of the use of the colors; the latter of cinnabar and Berlin blue: while Taylor (*British Medical Journal,* 1872; *American Journal of the Medical Sciences,* 1872, p. 561) employed sepia, ultramarine, and other tinting material to advantage, using a combination of lampblack with India ink, and a solution of nitrate of silver where an immediate and deeply-colored effect was desired. The following year, Ponti (*Annali di Ottalm.,* 1873, II, p. 507) and Osio (*New York Medical Record,* 1874, p. 589) wrote upon the same subject: In 1874, Klein (*Wiener medizinische Presse,* 1874) gave us a brief article upon the same, while Hirschberg (*Centralbl. für prakt. Augenheilk.,* 1887, p. 69) speaks of the plan. In 1903, Cofler (*Annali di Ottalmologia,*

1903, XXXI, p. 169) made use of blue, brown, red and yellow. The following year, Holth (*Annales d'Oculistique, CXXXX*) wrote an extensive and important article upon the same subject. Two or three years later Chevallereau and Polack contributed a valuable paper on tattooing of the cornea in colors (*Annales d'Oculistique,* 1906, July, p. 26). They made use of brown and red ochre, carbonate of copper, ivory black, Naples yellow, natural and burnt umber, and ultramarine blue. These materials, they say, are obtained chemically pure, and are reduced to a fine powder. They are made into a properly-colored mass by being mixed with distilled water, and sterilized by being exposed to a temperature of 150 C. Insoluble-in-water pigments which can be obtained in boxed sets at the present time are only those that should be used. They do not give rise to any reaction; though the sittings are both numerous and tedious. Baudry (*Technique Operatoire Oculaire,* 1902, p. 628) says that white is obtained from the salts of zinc or lead, blue from indigo and maroon from burnt sienna.

In 1873, Henry W. Williams (*Boston Medical and Surgical Journal,* 1873, IV), wrote a brief account of the plan, and Thomson (*Trans. of the Am. Oph. Soc.,* 1873, p. 36) described an instrument for the performance of the method. The same year Hasner (*Beiträge zür Phys. und Path. des Auges,* 1873) speaks of the different pigment colors. This communication was rapidly followed by similar articles by Archer (*Archiv für Ophthalm.,* XX, I, p. 225) and Hoch (*Archiv für Ophthalm. und Otologie,* 1876, I, p. 90), and much later by Vacher (*Bull. et mém. de la Soc. fr. d'Ophtalm.,* 1887, p. 248).

Alt, Browicz and Hirschberg have determined that the introduced pigment aggregates in the interfibrillar lymph spaces, cells, and deep portions of the epithelial layers, and in the anterior part of the corneal stroma. Pigmented thrombi can also be seen. Parsons confirms Hirschberg's findings. In 1894, Bajardi made an anatomic study of the infiltrated tissue, and gives an excellent illustration of the permeations. As early as 1876, Poncet gave us a careful histologic examination of the corneal tissues, which had been infiltrated with the coloring material. Lippay, while describing his method of staining the cornea, gives a brief account of the microscopic findings in a case of experimental tattooing.

Goldberg, in a most careful examination of such a case, found that the artificial pigment was "infiltrated in the walls of the interlamellæ and the canalicular spaces of the substance proper, leaving, in most cases, a hollow center." He states that the "corneal cells were in an unusually healthy state of preservation, and it was especially remarkable that but little proliferation of the connective tissues and

infiltration had taken place in spite of the amount of traumatism one might expect to find accompanying the operation of tattooing. It was also noted that the line of the epithelium had not been disturbed and that but few pathologic changes had taken place in the cells."

The operation is most suitable in old leucomas and solid flat scars of unirritable eyes. The procedure should be avoided in thinned and ectasic scar tissues; in fact, the pigment will not remain in such cases. The method cannot be done safely when any iris tissue is included in the scar.

Study of individual cases will determine to what degree and to what extent they should be subjected, the rule being that the less an eye is diseased the more favorable will be the result and the less dangerous will be the procedure to the integrity of the eyeball.

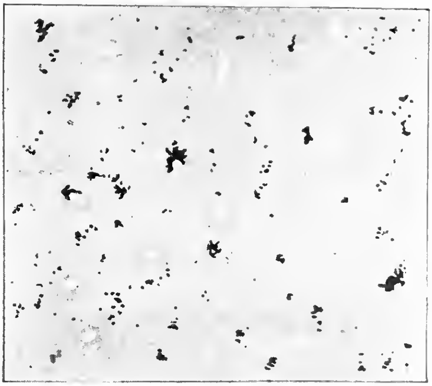
Coloration Massings in Old Pigmented Cornea. (Terrien.)

Sterilized Indian inks of variously desired colors (preferably black, as it is much more certain to be permanent), carefully tested on rabbits' eyes for their harmlessness, are the pigmentation materials that can be most successfully employed. In 1896, Hamilton described a capsule bacillus which was found in the Chinese inks. It is fairly well shown in the accompanying cut taken from an article on the subject by Sicherer. Mischina has shown that all forms of ink are practically sterile and that contamination takes place while they are being prepared for use.

Small amounts of each are rubbed to oily consistencies either with plain boiled water or with solutions of gum arabic, and placed in covered sterile saucers. De Wecker prefers to have the pigment material rubbed up in one to two-thousand strength solutions of bichloride of mercury. He keeps the mass in a hot air sterilizer pending its use. The conjunctiva is then cleansed with freshly-boiled water. A small piece of the pigment material is laid over the spot to be operated upon by the aid of a flat spatula. If other coloration tints (generally obtainable in the form of fine powder) are used, they

should be washed consecutively in water, alcohol, and ether, followed by evaporation in a sand bath, sterilized and mixed with an aseptic solution of gum arabic.

Formerly, a single grooved needle, that of de Wecker, kept saturated with the pigment, was repeatedly introduced obliquely into the membrane until a satisfactory result was obtained. Some surgeons remove the epithelium which overlies the corneal area that has been chosen for the pigment deposition, thus rendering the placing of the coloration material into the corneal lamellæ easier; while others have the patient's eyes kept widely opened by a stop speculum after the procedure, in order that the pigment may not be so readily washed away. The operation has to be done several times at weekly intervals.



Capsule Bacillus Found in Chinese Ink. (Oliver.)

It is a good plan, as suggested by Fox, to have the parts vigorously fanned during the proceeding, in order to produce rapid drying of the ink. Undue lachrymation may be avoided by frequent drying of the conjunctival sac with clean cotton gauze.

The present method is to use a pencil made of from four to eight round needles (Taylor's), though the outline of the staining can be better obtained with the broad single needle. The writer employs both plans to advantage.

The parts are rendered as clean as possible. The instrument is sterilized. Thorough cocainization is absolutely necessary. The eyeball is steadied with a pair of fixation forceps, the prongs of which are covered with hard rubber or tortoise shell to prevent tearing, which would permit the pigment to stain the sclerotic. As de Wecker tells us, it is not necessary to complicate the operation by employing a stop speculum to fix the lids apart, particularly when the procedure is

being made for optical purposes. The finger of the unused hand of the operator, or of an assistant, is sufficient to separate and to hold the eyelids in position. The needles are repeatedly thrust through the corneal epithelium sufficiently often and deeply enough to make a great number of minute canals for the reception of the ink, which is either driven in by the needles themselves or, which does not seem to be so good, freely rubbed in with a sterile spatula. The excess of the staining material is removed by free irrigation with a warmed sterilized solution of boric acid or chloride of sodium. The procedure is to be repeated until the desired-for effect has been obtained. If any of the pigment is carried into the anterior chamber, the parts must be thoroughly cleansed and the chamber must be immediately opened with a keratome and flushed free.

Tyson's method of corneal tattooing. Instead of using a bundle of needles, Tyson employs five needle points, the length of each being equal to one-half of the normal thickness of the cornea; thus reducing

Tyson's Tattooing Needle.

the liability of penetration into the anterior chamber, even in the thinnest cornea, to a minimum.

Originally, the needles were set in a curve, the radius of which equalled the radius of the cornea. With this setting, the author found that the end needles produced the best results, as by the yielding of the cornea the center needle did not penetrate sufficiently to give satifaction. He remedied this defect in instrumentation by having the needles set upon a straight edge. With this modification, the center needle penetrated first, followed by the end ones—thus producing more uniform penetration.

His plan of procedure is as follows: After sterilizing and analgizing the eye, a stick of Chinese-India ink is allowed to stand with one end immersed in boiling, sterile water until the submerged portion of the stick becomes softened to a pasty consistence. A small quantity of the softened mass is spread with a spatula over the parts to be tattooed. The tattooing needles are then repeatedly used, until as much ink as possible, or as may be desired, is forced into the corneal lamellæ. The site of the operation is kept moderately dry during the procedure. It is also occasionally wiped with moistened, sterile, absorbent cotton, in order to remove any excess of overlying ink, and to expose the actual amount of pigmentation which has been obtained.

When the desired color-results have been gotten, all of the loose

particles of pigment are removed from the corneal and conjunctival surfaces by flushing with a sterile solution of salt. A drop of pilocarpine is instilled into the conjunctival sac, a light compress bandage is applied, and the usual method of post-operative treatment is followed.

Unless the tattooing is done, for example, over an anterior synechia, very little, if any, reaction follows. In such cases the patient will experience some pain, notwithstanding local analgesia; and an increase in intraocular tension, which can be controlled by miotics, is apt to follow.

In Tyson's early cases he used atropine after the procedure, until a case of secondary glaucoma, which was checked in twelve hours' time, developed. Since that time he has employed pilocarpine with excellent results in every instance.

Tyson tells us that this method of procedure may require more sittings in order to obtain desired results; but, in his opinion, it is far less dangerous to the eye than the older method with the long needles, it being practically impossible to force any pigment into the anterior chamber with his instrument.

Froelich's method. The method of Froelich is a most excellent one for imitating the appearance of a pupil, particularly in cases in which there are broad, dense, flat scars. An area, equivalent in position, shape and size to the opposite pupillary one, is excised from the superficial layers of the cicatrix by means of a corneal trephine of von Hippel. The exposed surface is carefully scarified with the needle or a delicate scarifier. The pigment material, prepared to proper consistency, is rubbed into the exposed meshes of the scar, thus producing a good imitation of a black pupil. The surrounding area is graded into any desired shade and tinting by one of the needle methods. (The writer prefers to make the operation in two procedures, allowing sufficient time to elapse between them in order to observe the effect of the first.)

The after-treatment is the same as that which has been recommended for the previous forms of operation.

Holth employs a corneal trephine to outline the pupillary area. He pricks the entire surface to be pigmented before he inserts the ink, making use of both cocaine and adrenalin prior to the procedure. He calls attention to the priority of his claims for precedence of his method over that of Armaignac. He also tells us that Czermak as early as 1896 recommended the corneal trepan of von Hippel.

Barck's method of tattooing. In order to obtain the characteristic feature of a black central pupil, Barck has devised a double trephine (see the figure) which makes both the limits of the pupillary space

and the inner border of the iris-ring. After the obtainance of these boundaries by tattooing the central spot and leaving the surrounding area untouched, the tint of the periphery of the membrane is made to imitate the iris as much as possible wherever desirable.

Borsch makes a pigment mass which is somewhat thicker than ordinary black ink, with a solution of bichloride of mercury, one to five thousand per cent. strength. Starting with a central prick he carefully depicts a pupillary area around it. This is followed by an imitation of the iris and its striæ, the striations being made by a series of oblique needle thrusts which radiate from the pupil.

Armaignac has constructed a shield guide which is shaped like a bottomless saucer that exactly equals the size of the intended pupillary area. It is laid in position and fixed by small retaining hooks. It is then filled with the pigment massing, which is brought into direct

Corneal Trephine of Holth, Used in Tattooing.

contact with the area which is intended to be pigmented. The tattooing is performed in the included space. The greatest disadvantage that the contrivance possesses is that the field of operation cannot be made visible without removing the instrument. He has devised a second guide for the corneal size.

Nieden has constructed a useful fountain-pen tattooing instrument.

Hesse makes use of a trephine. He places the ink against the exposed area, and resets the trephined plate into position. He reports three successful cases.

Any slight reaction which is apt to take place, is, as a rule, readily removed by asepsis, cleansing, instillations of weak neutral solutions of sulphate of atropine, and non-use of the eye by the application of a light occlusive bandage.

The stain, even when most skillfully placed, may gradually diminish or may even disappear, during the course of years.

Coarse, chronic and incurable inflammatory reaction, which is said to have followed the procedure, has been probably the to-be-expected result in badly selected cases and from improper technique. Transferred ophthalmitis is a sequel which can be but deprecated as expressive of either ignorance, or carelessness in the question of choice of case. Weeks, in speaking of the method, says that he "has never seen any bad results; the epithelium is soon restored and healing is satisfactory, as a rule."

As de Wecker tells us, we must remember that as far as the method is concerned, "We are yet in the infancy of that art." He justly states, however, that to "accuse tattooing of having given rise, long after it had been performed, to certain untoward changes in eyes, already at the time much disorganized, is to interpret facts amiss."

In 1891, Hirschberg called attention to corneal staining in relation to pupil formation. The following year, Bajardi wrote an important paper upon the general subject.—(C. A. O.)

Webster Fox's (*Am. Med. Surg. Bull.*, Aug. 1, 1896) plan in this minor surgical procedure is as follows: After covering the leucoma with ink paste, the consistence of which is such that it does not run over the eyeball, he, with a piece of absorbent cotton removes the excess of ink over the tattooed spot. He does this for a double purpose, first, to see whether he has covered the whole of the leucoma, and, second, to see how much ink the needle-points have carried into the tissue.

Double Tattooing Trephine of Barck.

He sometimes, if the needles do not puncture deep enough, scarifies the tissue with the point of a Beer's knife. He again applies the ink paste and rounds out the edges of the leucoma. An important part of the process now follows. The eyeball is exposed to the atmosphere and were this exposure continued for some time the ink on the cornea would cake and become hard. He, with a piece of absorbent cotton, dries the eyeball of any lachrymal secretions, never touching the cornea, however. Then he fans the eyeball rapidly, which in a few moments dries the ink sufficiently to hold it in place, and again sees whether tears have gathered in the conjunctival sac: if so, he drains them off with cotton, removes the ophthalmostat, closes the eyelids and keeps them bandaged for twenty-four hours.

[A complete bibliography on the subject of tattooing will be found as footnotes to the late Chas. A. Oliver's chapter in Wood's *System of Ophthalmic Operations*, pp. 996-1005.—Ed.]

Cornea, Trachoma of the. In addition to the treatment of this subject under **Cornea, Pannus of the**, and under **Trachoma**, attention may be drawn to the observations of Calderaro (*Archiv f. Augenheilk.*, 69,

p. 35, 1912), who describes a peculiar corneal complication of this disease.

The affection has been observed in a large number of cases of chronic trachoma in southern Italy. It occurs with characteristic constancy in the center of the cornea, more particularly corresponding to the lower margin of the pupil. It begins with white, pear-shaped dots lying beneath Bowman's membrane, and corresponding to the termination of a minute vessel. These dots become more numerous and blend to produce a large spot; in which, however, the primary dots are still seen as dense centers of less marked opacities. The lesion is constantly accompanied by vessels, which increase in number and caliber as the spots extend.

The disease occurs in the cicatricial stage of trachoma, and mostly in young persons. Sometimes unilateral, sometimes involving both eyes, its growth is extremely slow, in one case having taken as long as seven years to reach a height of barely one millimeter. The tendency is for the disease to cover the pupillary area, and hence seriously to injure the sight. The corneal sensibility is unaltered, and anterior chamber, iris, and other internal coats of the eye remain healthy.

The opacity never covers the entire cornea. The author has never seen either spontaneous or therapeutic cure of advanced opacities, but when the opacity was still thin, treatment directed against the trachoma diminished the extent of the opacity. Quite small, incipient opacities disappeared completely under treatment in the course of two years.

Attempts to discover a special causative bacterium or mycelium were fruitless. Microscopic study of the opaque tissue was facilitated by the ease with which the little disc was separated from the cornea. The starting point of the changes was in the cells surrounding the terminal capillaries of the new blood-vessels; that is to say, in the perithelium. The process is therefore one of perivascular infiltration, the perithelial elements of which undergo a degeneration marked by the formation of protein granules, and later of fatty granules. In no case could the presence of carcareous infiltration be detected.

To remove the opacity the corneal lamellæ were opened with a Beer's knife, and the detritus curetted with a corneal spoon until the characteristic color of the spot was no longer observed. The result was cosmetically, but not optically, good, since the opacity was replaced by a semi-transparent leucoma. But relapses occurred, and to remedy these the author later adopted the plan of removing, by means of the trephine, the corneal parenchyma at the site of the opacity.

Cornea transparens. (L.). The transparent rigid coat of the eye—the cornea—as opposed to the opaque tunic—the sclera.

Cornea, Transplantation of the. Keratoplasty. This operation consists in the replacement of an opaque portion of corneal tissue by a clear section of the membrane. The procedure is indicated in cases of leucoma, where the cornea is so diffusely opaque that optical iridectomy would be of no avail. The corneæ of the lower animals, especially those of rabbits, are frequently used for transplantation, but most surgeons are agreed that the best results are obtained with the employment of living human cornea. The operation is known as total when the entire thickness of the cornea is removed preliminary to the insertion of the graft, and partial when only the layers down to Descemet's membrane are displaced. The few satisfactory results reported have been obtained when the latter procedure has been employed.

The attempt to replace the opaque cornea by clear corneal tissue is a surgical procedure of comparatively modern date. Less than one hundred years ago, Reisinger proposed to substitute the transparent cornea for the permanently opaque corneal substance. His experiments were conducted as early as 1818, and it is to him that credit for priority in this direction must be given. We are told that he successfully replaced the cornea of one animal with that of another, that adhesion promptly took place, and at the end of twenty days one-half of it was transparent.

Previous to Reisinger's time the treatment of leucomatous corneæ had occupied the thoughts of scientists and surgeons at least to some extent for some time. In 1775, Robert Mead recommended "the use of equal parts of powdered glass and sugar levigated into an impalpable powder." "A little put into the eye every day," he writes, "gradually absterges and wears off the spot by its inciting quality." Darwin, in 1803, inquires if surgery could not be beneficially employed in these cases. He asks, "Could not a small piece of the cornea be cut out by a kind of trephine about the size of a thick bristle, or a small crow-quill, and would it not heal with a transparent scar? This experiment is worth trying and might be done by a piece of hollow steel wire with a sharp edge through which might be introduced a pointed steel screw, the screw to be introduced through the opaque cornea to hold it up, and press it against the cutting edge of a hollow wire or cylinder. If the scar should heal without losing its transparency, many blind people might be made to see toleraby well by this slight and not painful operation. An experiment I wish strongly to recommend to some ingenious surgeon or oculist."

Almost coincident with the publication of Reisinger's paper, Möss-

ner gave the results of his experiments, which led him to the conclusion that as corneal tissue would not heal to the area from which it was removed, that, *a fortiori,* it would not unite with any other. Schön, a few years later, not only questioned the possibility of successfully transplanting corneal tissue, but vigorously opposed Reisinger's theory. His conclusions, however, seem to have been arrived at, not as the result of experimentation, but from pure conjecture.

Diffenbach's experiments, which extended over a considerable period of time, were successful; as were those of Drolshagen, Himley and Stilling, which were carried on about the same time. In no instance did the transplanted tissue unite perfectly, but in most cases contracted or sloughed, rendering the operations little less than failures.

Following this decade of fruitless experimentation, Wilhelm Thome succeeded in attaining a moderate degree of success. His experiments numbered eight, and his results encouraged others to attempt further investigation. About this time Bigger took up the work, carried on eighteen or twenty experiments, and expressed himself as well satisfied with the results.

He relates that the first time he had an opportunity of trying the experiment on one of the inferior animals was in 1835, a period when he was a prisoner with a nomadic tribe of Arabs twelve or fourteen days' journey from Grand Cairo. The subject of the operation was a pet gazelle which had lost one eye from "inflammation," and the power of seeing with the other from a wound of the cornea. "The cornea was taken from another animal of the same species brought in wounded but not quite dead; adhesion took place, and ten days after the operation the animal gave unequivocal signs of vision, and the upper part of the transplanted cornea remained perfectly transparent."

The experiments above referred to were all confined to the transplantation of one animal's cornea to that of another lower animal. The first attempt to transfer the cornea of an animal to a human being was made in America, the first operation of this kind being performed by Kissam, of New York. He reports that in 1838 he transplanted a portion of the cornea of a pig, six months old, to the eye of a man who was practically blind from a central leucomatous cornea.

He relates that he was led to perform this operation from reading the account of Bigger's experiments just related. He employed a Beers knife to remove a portion of his patient's cornea and attached the animal's cornea by means of two ligatures to points on a line with the angle of the tarsi. Vision improved immediately after the operation, but within a fortnight the cornea became opaque, and in the course of a month the attached portion was absorbed.

Almost simultaneous with Kissam's report, Wutzer, of Bonn, published an account of a case in which he transplanted the cornea of a living sheep to the eye of a human subject. The transplantation succeeded, but the cornea shortly became completely opaque.

In 1830 the medical faculty of Munich offered a prize for the best work on keratoplasty, and much of the experimentation which followed during the next decade may possibly be attributed to this stimulus.

Ranier de Schallern, Muhlhauer, Königshofer, Marcus, Munk, Hauenstein, Himley, and Feldman were among those who contributed papers relating to the subject. De Schallern devised a pneumatic machine in the form of a cylindrical tube, which he employed in the operation.

That Marcus, at that date, possessed a clear conception of the operative essentials of the procedure is shown by the rules which he formulated, viz., 1. An exact correspondence in the size and form of the graft and the opening is essential. 2. The graft must be rapidly transferred. 3. There must be ready fixation of the graft. 4. The internal structures of the eye must be prevented from being pushed forwards through the opening in the cornea.

Feldman conducted about twenty careful experiments on animals, in all of which, he states, the cornea became not only opaque but more or less irregular on their surface. Plouvier, after trying the operation on animals many times, grafted the cornea of a dog to that of a girl blinded by smallpox. The graft was secured by four sutures, became satisfactorily engrafted, but in a short time lost its transparency. Desmarres' attempts were likewise unsatisfactory.

In 1853 Nussbaum proposed making an opening in the opaque cornea and inserting a small piece of glass in the shape of a shirt-stud, hoping that it would be retained permanently and aid vision.

From 1853 to 1872 apparently but little progress was made along this line. In the latter year Power revived the subject of keratoplasty at the International Ophthalmological Congress. His report included experiments on 3 dogs, 3 cats, 4 rabbits, and 2 human beings. The two last cases were children who had extensive staphylomatous protrusion of the cornea as the result of purulent ophthalmia. In both, the cornea was of remarkable thickness, not less than $\frac{1}{8}$ inch. Power employed a sharpened brass Mohr's cork-borer in his operations. He reports that he had more or less success in all his cases. In the human cases union occurred by first intention and without irritation or suppuration. No sutures were employed. The transplanted tissue remained transparent or semi-transparent for some time.

In 1878 von Hippel published the results of his experiments on the lower animals, and his conclusions were that the subject of keratoplasty was worthy of further investigation. It is to this observer that great credit is due for the ingenious invention of the corneal trephine which has been of such aid in the perfection of this operation.

Dürr in 1877 proposed transplanting a portion of the cornea to which was attached a narrow strip of conjunctiva and sclera, the latter to serve as a flap to be attached by sutures to the surrounding parts. The transplanted pieces of cornea that he used were 5 to 8 mm. long, 5 to 6 mm. broad and 1 mm. thick, and were covered with epithelium.

Wolfe transplanted a portion of human cornea and employed flaps dissected from the surrounding conjunctiva to assist in retaining the transplanted portion in place, the grafts "adhering like adhesive plaster."

De Wecker employed a trephine by which he removed a piece of cicatricial cornea and replaced it by a similar portion cut from the clear cornea of an enucleated eye. He expressed himself to the effect that "we have no right in these cases to refuse the slightest aid to sufferers who have but this one remaining chance to recover a little sight; neither should we be deterred by the reproach of eccentricity which will certainly be leveled at anyone who shall attempt to graft a cornea."

In 1887 Adamük reported some experiments which he had conducted on fowl's eyes. He considered it important, as did Dürr, that some of the neighboring sclerotic should be transplanted with the corneal graft in order that the highest degree of nourishment might be maintained.

Johnson's experience with four cases in which he engrafted rabbits' cornea upon human subjects was to the effect that while the grafts fixed themselves and grew to the surrounding tissues without any difficulty, their vitality seemed gradually to decline, as shown by the progressive loss of transparency and by the absence of feeling when touched. They finally became red and opaque, lost their individuality, seemed to dwindle away, and at the end of three months it was impossible to say from the appearance of the eye that a corneal graft had been made. Fox, in 1888, reported the case of a girl of nineteen with opacities of both corneæ, the sequel of a pronounced keratitis, in which, two months after grafting, the vision was considerably improved and the transparency of the transplanted cornea was progressing.

In 1888 von Hippel, who for ten years previously had made hundreds of experiments on animals and human subjects and who was

unquestionably the first to successfully transplant a portion of corneal tissue to a human being and have it permanently retain its transparency, called attention to an important feature of the subject of keratoplasty which to that time had not been duly considered. Many experimenters had successfully transplanted corneal tissue, but in every recorded case the graft had sooner or later lost its transparency. Acting on the suggestion of Leber, who first directed attention to the fact that the transparency of the cornea depends upon the integrity of the epithelium lining Descemet's membrane and that disturbance of the latter through entrance of the aqueous humor leads to edema and opacity of the adjacent tissue, von Hippel abandoned the idea of replacing the entire thickness of the cornea and stopped short of the removal of those protecting structures. In the first three cases in which he employed the new procedure he met with failure, the graft becoming opaque. This he attributed to faulty technic, undoubtedly due to traumatism of the graft in dissecting it from the animal (a dog) which he employed. He then decided to remove the graft from a smaller animal, that the entire thickness of the cornea might be removed. This attempt was successful and the graft retained its transparency. The patient, whose vision was increased from the counting of fingers at two meters to 20/200, was exhibited at the meeting of the Ophthalmological Society in Heidelberg in 1886 and 1887.

Wagenmann approved the method of von Hippel and laid especial stress on the importance of extreme gentleness in handling the graft, both in its incision and its replacement.

Chisolm declared that the *sine qua non* of a suitable case for operation is a perfect elastic membrane of Descemet and a normal anterior chamber filled with aqueous.

Baker reported a number of experiments on rabbits by Wolfe's method. When the operation was carefully performed, the cornea united and remained clear for one or two weeks, after which it gradually became opaque; the eye usually became soft and phthisis bulbi resulted. The results were so discouraging as to deter him from attempting the operation on the human eye. He cites the interesting case of a man "into whose eye he inserted a glass button, which was retained for two years without causing any particular trouble." There was temporary improvement of vision, but the globe eventually became soft and shrunken. The patient was a druggist whose eyes were injured by an explosion while charging a soda fountain. Both corneæ sloughed as a result of the accident.

Gradenigo is quoted as successfully transplanting the cornea from

the eye of a barn fowl into the eye of a human subject. On the eighth day after the operation the transplanted cornea is said to have presented "quite a pellucid and convex appearance."

Fox also attempted to transplant the cornea of a chicken, but the result was not satisfactory, the transferred cornea becoming shrunken and opaque.

W. F. Smith reported the transplantation of a portion of a rabbit's cornea to the eye of a woman, who was practically blind as the result of smallpox, which partially retained its transparency at the end of fifteen months. He employed a simple trephine which he had constructed. His experience covered five attempts at transplantation, and the instance cited was the only one that approached success.

Fuchs, who had conducted more than fifty experiments on animals, expressed the belief that the operation is justifiable in certain cases.

In 1907 O'Meara described a procedure which he believed to be superior to the use of the trephine. Under cocain anesthesia he transfixes the opaque cornea with a Graefe knife and cuts off a superficial slice of opaque area, repeating the process and employing the knife to make the half section after transfixion until the opaque tissue is removed. A dog is then rapidly killed with chloroform. Three or four sutures of fine silk are passed through its cornea at equal distances around the margin of the membrane. The canine cornea is then dissected out in its entirety, placed in position on the raw human cornea (after the parts have been carefully dried) and secured to the conjunctiva by the sutures. If the anterior chamber is opened and the aqueous escapes, the operation is postponed and the eye closed for a few days, when the surface is again freshened. O'Meara believes that the advantage of this operation lies in the fact that one can, while operating, more definitely determine the depth of the incision in the cornea than is possible with the trephine.

Zirm has reported an exceptionally successful case of keratoplasty. His patient was a man of forty-five, whose corneæ were almost entirely opaque as the result of a burn by unslaked lime. Vision was reduced to the perception of hand movements. With von Hippel's trephine a disc of clear cornea was removed from the cornea of a boy of eleven years, whose eye had been lost by a fragment of steel, and transplanted the disc to his patient's eye. It was retained by two sutures placed in the conjunctiva and drawn across the cornea in the form of a St. Andrew's cross. Care was taken not to touch the corneal disc with forceps, scissors or knife. The graft healed kindly, and in a subsequent article Zirm reports that the patient continued to improve so that more than a year after the operation vision was 6/36

with a stenopaic disc, and with convex glasses (16 to 20 D) patient could read Jaeger 4, with difficulty. Zirm considers the following points essential to a successful operation: 1. The exclusive employment of human cornea for the graft, preferably the cornea of a healthy young person. 2. The exclusive use of von Hippel's trephine and the instillation of eserin if the anterior chamber is present. 3. Profound anesthesia during the operation, strict asepsis and the avoidance of antiseptics. 4. Protection of the graft between pieces of gauze moistened with sterile physiological salt solution kept warm by steam. 5. Retention of the graft in position by two sutures attached to the conjunctiva and forming a cross over it. 6. Selection of cases.

Valk, from experience of three cases, believes the operation of keratoplasty fully justifiable. It may be tried in all cases of *leucoma totale* and of dense pannus following old trachoma after the cicatricial stage has passed.

Lesser reports the case of a man, twenty-four years old, whose vision, perception and projection of light, improved to the counting of fingers at twelve inches three months after he had transplanted a disc of cornea from a rabbit to his patient's cornea. Von Hippel's trephine was used and the cornea was removed only to Descemet's membrane.

Plange published the report of a case in which, several months after operation, the vision of his patient equaled the counting of fingers at four meters.

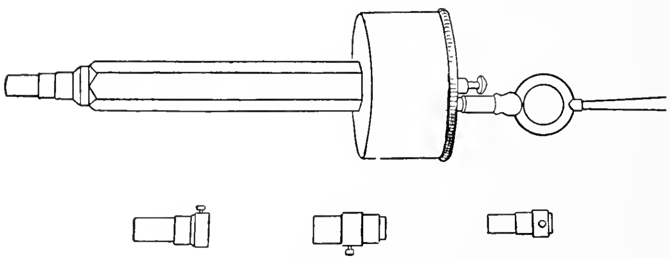
Calderaro removed a small circumscribed tumor from the cornea of a woman of sixty-six and transplanted a disc from the eye of a woman of fifty-two, blind from absolute glaucoma. The trephine of von Hippel was used, and he held the transplanted portion of cornea in position by gentle finger pressure for fifteen minutes, a procedure to which he attributes much of the success he attained in the case. Thirty days after, the patient's vision had improved to 1/20.

The result of all this experimentation appears to be the complete success of the operation in two well-authenticated cases, those of von Hippel and Zirm. In both, transparency of the cornea remained for a period of more than one year, which would seem to indicate the permanency of the results.

Indications for corneal transplantation and the essentials of operative success. From the experience of those who have given much time and labor to experiments in keratoplasty, it will readily be noted that the field for this operation is rather a limited one, and the prospects of success are not particularly encouraging. In the first place, the surgeon would not for a moment consider the performance of the opera-

tion in a case where optical iridectomy would offer the slightest possibility of success. On the other hand, the chances for success seem to be exceedingly slight in those cases one so frequently sees, in which, as the result of purulent ophthalmia, the cornea is staphylomatous, markedly thickened and white; and, as a result of perforating corneal ulcer the anterior chamber is to a greater or less extent abolished and the iris is entangled in the corneal cicatrix. A clear, intact and elastic Descemet's membrane seems to be essential to a successful operation. Such a condition is not uncommonly encountered in corneæ that have been the subject of superficial ulceration, severe pannus, burns by lime or other cauterants, and the opacity resulting from the encroachment of growths.

The operative maneuvers must of necessity be exceedingly delicate, and scrupulous attention must be paid to the details of general surgical technique. No one should consider operating on the human



Von Hippel's Trephine.

subject until he had thoroughly mastered the details of procedure by experimentation on the lower animals. The employment of the trephine of von Hippel is, in the writer's opinion, essential to successful operation.

Description of von Hippel's trephine. This ingenious instrument consists essentially of a tube in which is enclosed a circular knife whose cutting edge is protected by a collar which controls the depth of the incision. At the opposite end is a spring which, when released by pressure on a small button, sets the knife in rotation. There are usually two or three circular knives of various diameters accompanying the set. The spring attachment is wound by a key. The instrument is arranged so that the knife may be "set" for cutting various depths.

Von Hippel's operation. The instruments required are an eye speculum (or a pair of lid retractors), fixation forceps, the trephine, a Graefe knife, and a pair of iris forceps.

Cocaine anesthesia is commonly employed. The lids being well separated, the globe is steadied and the trephine is applied with gentle pressure at a right angle to the cornea over the opaque area it is desired to remove. The trepan has previously been set to cut the estimated depth which of necessity requires the removal of the tissue down to, but not including Descemet's membrane. The button at the top of the instrument is touched by an assistant and the knife being released, rotates automatically. The trephine is then removed and the trephined portion is carefully dissected off by the aid of an iris forceps and Graefe knife, leaving the membrane of Descemet exposed. This step in the operation is a decidedly delicate one and aims at leaving as thin a posterior layer of cornea as possible, at the same time removing a disc of equal thickness throughout. The third step

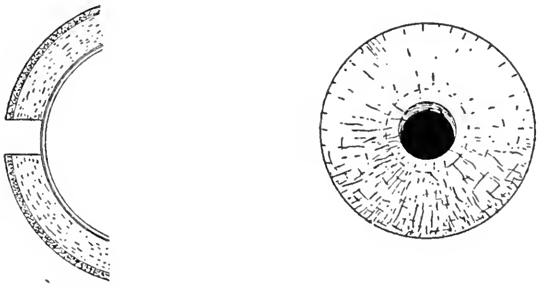


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Fig. 491.
Von Hippel's Trephine.
(a) Profile of Cornea Showing Layers with Disc Removed Down to Descemet's Membrane; (b) Front View of Cornea Showing Disc Transplanted.

of the operation consists in the excision, with the same trephine, of a piece of the cornea either of a rabbit or of a human being. In this procedure the incision must go completely through the entire thickness of the cornea. The corneal disc thus incised is placed over the trephined area of the patient's cornea and gently pushed out of the trephine by a delicate wire probe which passes through the instrument into the corneal opening. It is thus seen that the graft is touched by no instrument except the trephine itself. It does not matter if the surface of the graft lies a little below the plane of the cornea, but if it protrudes above the surface it is liable to become displaced. Powdered iodoform is usually dusted over the cornea and a moderately firm bandage is applied. The eye should be inspected at the end of two or three days and after that the dressing may be changed daily. Healing is usually complete in three weeks.

There is usually moderate hemorrhage when the leucomatous tissue is incised. This is best arrested by the use of pledgets of cotton soaked in bichlorid solution cooled on ice. If thought best, in the judgment of the surgeon, the graft may be kept in place by the aid of sutures extending across the cornea in the form of a cross as suggested by Zirm.—(W. O. N.)

[A complete bibliography on this subject will be found, as footnotes, pp. 1013-1024, in Wood's *System of Ophthalmic Operations.*—Ed.]

The work of Magitot (*Annales d'Ocul.*, 145, p. 53, 1911; *Ophthalmoscope*, p. 477, 1911) in preserving the living cornea outside the body for subsequent use in replacing opaque tissue is of extreme importance. He has found that with repeated washing of the tissue with Locke's solution, and then preserving it in hemolyzed blood-serum of the species of animal from which the cornea is taken, at a temperature from 5° to 8° C., the corneal tissue, both parenchyma and epithelium, can be kept alive for more than two weeks. In one case it was preserved for twenty-five days, by changing the fluid once in five days. The full vitality of the tissue thus preserved was demonstrated by grafting it into the cornea of another animal of the same species. After this is done a portion of the graft (about one-fifth the thickness) disappears by absorption. The remaining fibers and cells preserve their normal appearance. The epithelium of the surrounding cornea fills up the groove, and joins the epithelium of the graft which remains intact. The graft continues transparent; but presents irregular astigmatism, which subsequently diminishes.

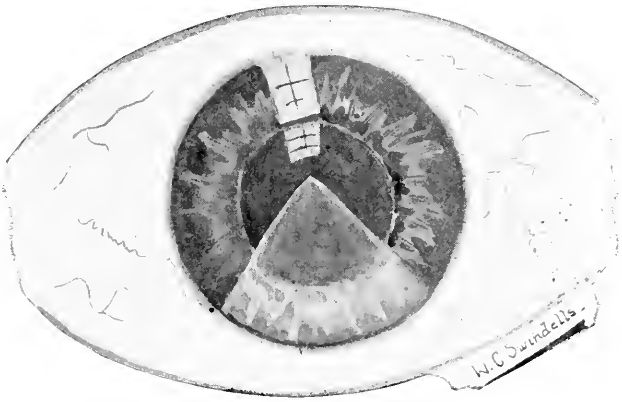
[*Locke's Solution* was first used for maintaining the activity of the isolated mammalian heart. The solution consists of sodium chloride potassium chloride, calcium chloride and sodium bicarbonate in the proportion in which they exist in blood serum, with the addition of a small quantity of dextrose.—Ed.]

Magitot (*Jour. Am. Med. Assocn.*, p. 18, 1911; and *Archives d'Ophtalm.*, 32, p. 361, 1911) reports a case in which a boy of fourteen, with a cornea almost entirely opaque from lime-burn, had a rectangular window made in the opaque tissue 4 mm. by 5 mm. in size, extending down almost to Descemet's membrane. In this window was fitted a graft from the cornea of an eye enucleated eight days previously for absolute glaucoma. At the time of enucleation the cornea had been steamy, but it cleared up in a few hours after being placed in the preserving fluid. When the bandage was removed on the third day the graft was transparent, and fluorescein did not stain at any point. Eight days afterward the eye was left uncovered, and the fundus reflex could be seen through the new window. Irregular

astigmatism was present but gradually diminished. At the end of a year the boy had vision of 1/7 through the corneal window. His vision, before the transplantation had been 1/17, through a peripheral optical iridectomy. Magitot suggests that this method can be employed to utilize, for purposes of transplantation, the corneas of still-born children; and he calls especial attention to this successful use of a cornea apparently damaged by high intraocular tension.

Lohlein (*Arch. of Ophthal.*, May, 1912) has also reported a case in which he transplanted a corneal segment from one human eye to another. The visual result, one year after operation, was 3/xviii vision with —1.00 D. sphere. His last observation records the eye as white and not irritated; no photophobia present; the corneal flaps unchanged and its sensibility somewhat less than that of the rest of the cornea.

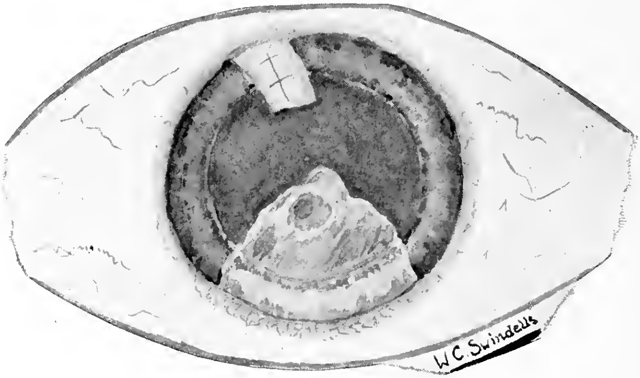
Cornea, Triangular opacity of the. A description of this rare deposit is given by W. C. Posey (*Practical Medicine Series*, 1907). A lad of seventeen years with congenital syphilis, suffering from interstitial



Triangular Opacity of the Cornea. (Posey.)

keratitis, developed in one eye a superficial triangular opacity of the cornea, extending from its base to its center. This opacity seemingly was made up of thickened epithelial and subepithelial elements. It had a glistening, white appearance, was slightly raised above the surrounding tissues and had sharp lines of demarcation. The eye was under observation by Posey for nine years and the opacity underwent no change. His second case was that of a colored woman, aged thirty-two years, with acquired syphilis in the late secondary or early tertiary period. One cornea presented an opacity very similar in

appearance, size and position to that of the boy above described. The tension was + 1. There were evidences of excavation of the nerve



Triangular Opacity of the Cornea. (Posey.)

head and of uveitis. This case has not been observed long enough to determine the influence of treatment. See the illustrations.

Cornea, Tubercle of the. Corneal tuberculosis. Keratitis tuberculosa. Primary tuberculosis of the cornea is exceedingly rare, although cases have been reported, among others, by Panas and E. Smith.

The cornea sometimes becomes involved as an extension from a similar process in the uveal tract or elsewhere. By some observers it is held that hematogenous infection of the uvea is of frequent occurrence, but that ectogenous infection cannot be entirely excluded. The process in the cornea may appear as an interstitial keratitis, or may show characteristics resembling sclerosing keratitis. Miliary tubercles may appear as deeply-placed, small, grayish nodules, exhibiting one form of phlyctenular keratitis (q. v.). Tubercle bacilli have not been found in these lesions. In a case studied microscopically by Villemonte, a nodule 1½ cm. in size, situated astride the limbus (the larger portion upon the cornea) contained no tubercle bacilli and little fibrous tissue but a number of tubercular follicles, giant, lymph and plasma cells.—(J. D. L.)

The Editor believes that this is probably a more common disease than has been previously suspected. The best treatment is that by tuberculin injection, the application of the electro-cautery, such disinfectant lotions as a saturated solution of boric acid (with atropia) in 1 to 5,000 of sublimate, and the employment of a dusting powder of iodoform, xeroform or some other substitute for the former remedy.

S. Lewis Ziegler has reported a case of keratitis tuberculosa treated

by tuberculin. The right eye was affected, the nodes being located in Descemet's membrane. In the onset the case closely resembled interstitial keratitis, the salmon-colored patch and vascularized marginal ring being present. Later, isolated tuberculous nodules appeared.

For two months tuberculin injections of 3 to 5 minims had been administered once or twice a week. There had been a local reaction twice, and a systemic one three or four times. Improvement had been slow, but steadily progressive, and the patient rapidly convalesced, although the central opacities in Descemet's membrane would doubtless interfere permanently with good central vision.

Several abstracts from the *Ophthalmic Year-Book,* 1909-1912, deal with this important subject. Derby (*Trans. Am. Oph. Soc.,* 1908) tried the von Pirquet test in sixteen cases of relapsing sclerokeratitis and in three cases of parenchymatous keratitis, and in every case got a positive reaction. As a result of the introduction of the various tuberculin tests, the percentage of ocular diseases attributed to tuberculosis has greatly increased. While these reactions are of great value, the postive reaction is not absolute proof that the diseases in question are directly caused by the tubercle bacillus. The tubercle bacillus has never been discovered in the human cornea in these diseases unless accompanying the tubercular follicle.

Posey (*Ophthal. Record,* Aug., 1908) speaks of a yellowish-white infiltration from the limbus into the parenchyma, forming discrete oval areas, appearing caseous, as significant of tuberculosis. He has seen deposits on the posterior surface, appearing like cold mutton-fat, in tuberculous iritis and uveitis. He adopts Bach's classification of tubercular disease of the cornea:—(1) The parenchymatous type, from the action of toxines on the parenchyma. (2) The sclerosing type secondary to disease of the pectinate ligament. (3) Keratitis of the sclero-corneal margin unassociated with disease of the iris or pectinate ligament. (4) Corneal affections secondary to bacillary tuberculosis of the conjunctiva. (5) Sclerosing parenchymatous keratitis of tubercular origin.

Coover reports a corneal disease, probably tuberculous, occurring in an eye which had been injured twelve years previously. The lens was dislocated and opaque; for years the eye had been irritable. Recently yellowish-white, crescentic, superficial opacities had appeared, together with a central loss of substance having sharp edges and an even floor, and extending down to the lamellæ. There were buff-colored deposits upon Descemet's membrane in the upper and lower halves of the cornea. There was a tuberculous family and personal history, and the tuberculin reaction was positive. Injections

of tuberculin were given for three months, but the eye continued painful and enucleation was done. The microscopic examination had not yet been completed.

Stanculeanu (*Annales d'Oculistique,* p. 276, 1909) inoculated the corneas of rabbits and dogs with both human and bovine tuberculous material. From injections of the human virus he obtained an infiltration tending to spread superficially and later to ulcerate and destroy the cornea. Following the introduction of bovine material the infiltration took the form of points and lines which healed in a month, leaving no opacities. The infiltration after the inoculation of the paratuberculous bacillus of Timothee also ran a mild course. In Peters' case of tubercular keratitis there developed an elevated, indurated, grayish-red plaque 4 mm. square at the outer, lower quadrant. The lesion spread around the cornea, revolving about the center. There were also signs of pulmonary disease. A cure was effected by curettement and the application of formalin. Nakagawa (*Archives of Ophthal.,* p. 301, 1909) inoculated the cornea of rabbits with tubercular virus. In five days there developed corneal infiltration and, later, swelling and nodular formation in the iris. Under the microscope there appeared leucocyte infiltration between the lamellæ, and tubercle formation in the posterior layers and projecting into the anterior chamber. At the bottom of the anterior chamber the spaces of Fontana were filled with tubercular follicles.

Wemmerslager (*Zeitschr. f. Augenheilk.,* p. 236, 1909) describes three cases of what he terms keratitis profunda, sclerotizans, tuberculosa. Besides scleritis and mild iritis there was deep corneal infiltration which coalesced, became vascular and ended in fibrous tissue formation. The primary disease was shown by the anatomical examination to have been scleritis. There was thinning, vascular dilatation and some giant cells, but no caseation. The ciliary body was unaffected. The corneal changes were limited to the deeper layers. The earliest changes were deeper, the later ones more superficial. In the cornea were found newly-formed blood-vessels surrounded by infiltration, thrombosis, giant-cells, granulation and fibrous tissue formation. The disease occurred in young subjects. The tubercular reactions were positive. Coover reports a case in which repeated severe inflammation and deep degenerative changes occurred in the cornea and uveal tract. The patient was suffering from tuberculosis and the local conditions improved under the use of tuberculin.

Laas cured a severe case of bilateral parenchymatous disease by injections of tuberculin, TR. There was tubercular personal and family history, and syphilis was probably inherited from the father.

Improvement was noted after ten injections in three weeks. He began with 15/1000 mg. and ended after four months with 16/1000 mg. A second case in a woman of forty, who had a history of pleurisy, was cured after fifteen injections. Kalaschnikof praises pilocarpin and Selenkowsky, dionin, for the clearing of the opacities resulting from parenchymatous keratitis.

An elaborate discussion of this condition and its treatment by tuberculin is based, by Godechoux (*Ophthalmoscope*, p. 804, 1911) on a report of three cases. In this condition the diagnosis cannot be based upon finding the bacillus, or the histologic examination of the tissue, or upon inoculation; but the exclusion of other causes, including the failure of mercurial treatment, the clinical appearances and results of tuberculin treatment justify the diagnosis. He used Koch's old tuberculin, making the injections every second day; at first subcutaneously to watch for reaction, and later in the gluteal region. Fromaget and Mongour (*Recueil d'Ophtal.*, 33, p. 49, 1911) report the case of a girl of fifteen, presenting parenchymatous keratitis and infiltration, and two gray nodules in the cornea. Five injections of Marmorek's serum were given at intervals of eight days. The cornea cleared up rapidly and entirely.

Campos and Tourinho report the case of a man of twenty-two, who had suffered for two or three years. He gave a positive Wassermann reaction, but antisyphilitic treatment produced practically no result. He was placed on injections of old tuberculin, gradually increased according to Schöler's method. In all, fourteen injections were given in about ten weeks. The inflammation of the eye was gradually reduced, and vision rose from hand movements to 1/2. In the case reported by Krauss, improvement continued for some time after the cessation of the tuberculin treatment.

A form of local reaction to tuberculin resembling keratitis profunda has been studied by Tobias (*Klin. Monatsbl. f. Augenheilk.*, p. 172, 1911), with the help of the Zeiss loupe. On the second or third day after diagnostic injections, fine rounded, hazy, punctiform grayish infiltrations develop in various layers of the corneal parenchyma. They subside in a few days, leaving the cornea perfectly transparent. These, Tobias considers as characteristic as the more general tubercular reaction.

Cornea, Tumors of the. Neoplasms and other growths involving the cornea are discussed under captions proper to each tumor, as well as under **Tumors of the eye.**

Cornea, Ulcer of the. CORNEAL ULCER IN GENERAL. This study of corneal ulcer as a whole may be regarded as introductory to, and

complementary of, such other headings as **Cornea, Serpent ulcer of the**, as well as **Cornea, Simple ulcer of the.**

In considering the evolution of the suppurative keratitides it is important to determine whether they are of primary or secondary origin, to study the organisms responsible for the infection and to note the clinical characteristics of the ulcerative process.

By *primary* infections of the cornea we understand those processes that first appear in the cornea itself and are not dependent upon or associated with other diseases. Primary corneal ulcerations are, however, rarely "idiopathic," as traumatism, by mechanical or chemical agents, is usually the predisposing cause of the lesion.

Secondary corneal ulcerations have their origin in some other ocular or neighboring structure, most frequently in extension from the conjunctiva or the lachrymal sac; the former, except when due to infections by gonococci or Klebs-Loeffler bacilli, are usually superficial and marginal, while the latter are deep and more central (serpiginous).

Corneal ulcerations, due to impaired nutrition, are usually torpid and are not, strictly speaking, either primary or secondary and may, therefore, be classed as intermediate types. Examples are found in absolute glaucoma, in those ulcers that develop at the site of old corneal scars and have undergone atheromatous degeneration; and ulcerations due to serious general diseases. Corneal ulcerations generally pass through three important stages: *progressive, regressive* and *cicatricial.*

The condition which frequently precedes the appearance of corneal ulceration is corneal haze, or infiltration, induced chiefly by polymorphonuclear leucocytes, the result of the infection. Microscopical examination of the secretions of an accompanying disease of the conjunctiva rarely fails to reveal the presence of morbific micro-organisms.

Corneal infections may be produced in three ways: first, by microorganisms arising from without (ectogenous); second, in rare instances, by organisms derived from the blood stream (endogenous), or from contiguous tissues as a complication of diseases of the conjunctiva or uvea; and, third, by toxins.

Whether an ulcer is eventually circumscribed or diffuse, it has its beginning as a single spot, the early infiltrate appearing as a small, dull, smoky area. If the process is arrested promptly resolution occurs and the area of infiltration disappears; or, when control is not possible, necrosis intervenes. Perforation of the cornea frequently marks the termination of deep and serpent ulcers, and almost always occurs in those cases in which the entire cornea is involved, total anterior staphyloma also marking its termination. In ophthalmic literature

we find reports of cases of corneal ulceration said to occur without any initial break in the corneal epithelium. This theory, however, is considered untenable by many authorities, who maintain that infection, without a defect in the epithelium, does not occur. This should not be interpreted as applying to certain corneal diseases which are not the result of microbic infection. However, some authorities maintain that corneal ulceration, without abrasion, may result from prolonged contact with discharges containing the gonococcus or Klebs-Loeffler bacillus.

Following the appearance of the primary corneal haze, the epithelium exfoliates, as indicated by the dulled appearance at the point of the infiltration; after which there is a breaking down and loss of substance of the parenchyma.

In infected ulcer a zone of infiltration surrounds the lesion and from its gray and cloudy walls numerous gray striæ radiate into the surrounding transparent cornea, and the ulcer base is seen to be uneven. The progress of an ulcer is marked, as a rule, by a uniform increase in its depth and breadth; sometimes, however, it progresses in a single direction, as is observed in typical ulcus serpens. This clinical picture is descriptive of the *foul, unclean,* or *progressive* ulcer. In favorable cases, i. e., when early resolution takes place, there is a *limited* loss of structure over the most pronounced area of infiltration. In these cases the corneal tissues possess sufficient nutritive power to resist the extension of the necrotic process beyond the barrier presented by the zone of infiltration. Then follows the regressive stage, which means that the ulcer has become more or less aseptic and the process of destruction has terminated.

Leber's biological theory, confirmed by Römer, is that in the normal cornea there is only a small number of antibodies, but that during the active stages of inflammation of this non-vascular structure, conditions are brought about which encourage the admission of antibodies into the corneal tissues. Fuchs, by inoculating the corneæ of animals with various pyogenic organisms, has explained, as a result of these experiments, how infectious, suppurative keratitis is produced. Following the inoculation, the cocci multiply in numbers and the cornea, for a certain distance surrounding the point of inoculation, perishes as a result of the powerful toxic substances excreted by the germs. Leber believes that substances produced by the bacteria exert an irritant action upon cell protoplasm when slightly concentrated, but when possessed of strong toxic properties they paralyze the cells. The result of the former is to attract the cells toward the area of inflammation, a phenomenon known as *positive chemotaxis,*

which may be explained by the action of the aggressins—bodies supposed to inhibit the paralyzing properties of aggressinogens on the leucocytes; while the effect of the latter is to paralyze the cells and render them unable to reach the inflammatory focus, a condition known as *negative chemotaxis,* for which the aggressinogens are probably responsible. Clinical examples of negative chemotaxis are occasionally seen in the early stages of corneal infections in which there is a zone of clear cornea interposed between the infected area and the ring of infiltration.

Unfavorable cases of corneal ulceration are marked by a continuation of the infiltration and subsequent destruction of the tissues thus involved. When the deep layers of the lamellæ share in the process in advance of the surface necrosis, Descemet's membrane may protrude into the anterior chamber as a result of the formation of exudates derived from the ciliary vessels, producing a condition known as *internal ulcer* (q. v.). In that event Descemet's membrane sometimes splits, or actually ruptures.

The irritative symptoms, which accompany the progressive stage of an ulcer, are ciliary injection, photophobia, lachrymation and pain. When iridian complications intervene, they are marked by hyperemia or true iritis, indicated by a contracted pupil, discolored iris, turbid aqueous and posterior synechiæ. In the absence of irritative symptoms, the ulcer is known as *torpid* or *asthenic,* yet such an ulcer may be as destructive as that plainly marked by symptoms or irritation.

With the cessation of fresh infiltrates and the formation of reparative vessels, we know that the *regressive* stage has arrived and that further destruction is, generally speaking, not to be feared; that the infiltrated area will become transparent by resorption of the exudate—in other words, the ulcer has disinfected itself. The base and edges of a "clean" ulcer are smooth and the excavation can be recognized by the corneal reflex, as there is little or no opacity.

In *ulcus rodens,* Andrade believes that he has isolated a specific bacillus, which he describes as small, rod-shaped, aërobic and Gram-positive organisms, lying side by side, in groups and sometimes in chains. In the pathogeny of infectious corneal ulcers, numerous distinctive bacteria are also found. The perfection of the microscope and the discovery of these micro-organisms have placed the study of corneal ulcerations upon a new and more comprehensive etiological basis.

In infections of the cornea the following micro-organisms are most commonly present: the *gonococcus,* always secondary to a gonorrheal inflammation of the conjunctiva. The characteristics of this ulcer are its tendencies to increase rapidly in depth and area and perforate

the cornea; the *pneumococcus,* the common cause of typical ulcus serpens. This ulcer is often disc-shaped (crescent ulcer), appearing at the center of the cornea and extending in one direction. It is associated with hypopyon and iritis and is rarely seen in patients before the fortieth year. It is frequently associated with dacryocystitis, developing when a break in the corneal epithelium occurs. In lesions due to the *streptococcus pyogenes,* the ulcers are small and grayish in mild infections and are frequently associated with impetigo. In other cases, especially in badly-nourished children, rapid, yellowish, sloughing of the entire cornea may be seen.

In the ulcer due to the *diplobacillus of Morax-Axenfeld,* the disease nearly always appears at the corneal margin in association with an angular conjunctivitis. Diplobacillus ulcer of the cornea is sometimes difficult to distinguish, clinically, from typical pneumococcus ulcer. The progressive margin, according to Zade, is more shallow and glassy in appearance than in ulcus serpens. The ulceration that follows the diplobacillus is not as severe as that resulting from pneumococcus infection.

The ulcer produced by the diplobacillus of Petit is always primary, as this organism does not cause conjunctivitis. The clinical features of this rather rare ulcer are not characteristic. The ulceration is superficial, although commonly associated with hypopyon.

Corneal ulcer due to the *bacillus of zur Nedden* is generally situated from one to one and one-half mm. from the limbus, is superficial and associated with a localized, conjunctival injection. Following the breaking down of the infiltrate, a crescentic, marginal ulcer forms, which extends at its extremities, and spreads by the confluence of other ulcers formed in similar fashion.

The *bacillus of Koch-Weeks* rarely produces corneal ulceration; when it does, the ulcer is superficial, marginal, and associated with conjunctivitis due to the same organism. Hypopyon is usually present.

The *bacillus pyocyaneus* has been found in severe serpiginous ulcerations.

Staphylococcus ulceration does not attack any particular part of the cornea. The process is ordinarily superficial, moderately severe and associated with hypopyon. Infection due to the *staphylococcus aureus* has been responsible for ulcerations sufficiently severe to bring about sloughing of the whole cornea.

The *bacillus coli communis* has been found in corneal ulcerations with hypopyon.

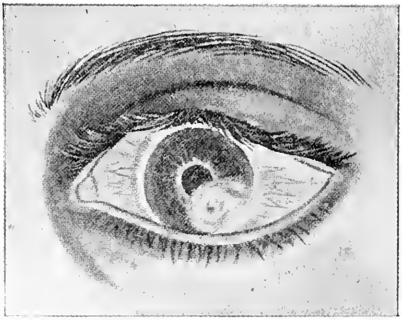
Infections of the cornea due to the *bacillus tuberculosis* are rarely primary; when they occur as direct infections they usually follow an

injury. Secondary infections are extensions of a tubercular ulcer of the conjunctiva or follow tuberculous infections of the iris or ciliary body.

The *bacillus of Klebs-Loeffler* attacks the cornea by extension from the conjunctiva and produces ulcerations which are, as a rule, rapidly destructive of the cornea. Ulcers due to this bacillus have even resulted in panophthalmitis.

Corneal ulcerations due to mould fungi will be discussed under the heading, **Keratitis, Mycotic.** See, also, **Bacteriology of the eye.**

The *stage of cicatrization* begins only when an ulcer is free of microbes. The new-formed (reparative) vessels then approach the ulcer from a point corresponding to the ulcer margin nearest the limbus. During the filling-in process, the ulcer is more cloudy than it



Fistulous Ulcer of the Cornea. (Würdermann.)

was during the cleansing process and, at the same time, it becomes more and more shallow until either the normal contour of the cornea is restored, or, when incomplete, there is more or less flattening at the point of previous ulceration—a condition known as *corneal facet.*

Congenital opacities, the result of aberration of development do not usually disturb the corneal curvature. In some cases, the cicatrices rise above the level of the adjacent cornea. This anomaly is due to bulging of the thinned floor of the ulcer; when it is permanent it becomes an *ectatic cicatrix* or *keratectasia ex ulcere.*

Perforation of the cornea results from an ulceration that has destroyed all the corneal layers. Actual escape of the aqueous may be preceded by bulging of Descemet's membrane and some of the deepest corneal layers (keratocele) before they succumb to the ulcerative process, or yield to the intraocular pressure. Descemet's membrane possesses greater resistive powers to inflammatory processes than the other corneal layers and is the last to succumb to suppuration.

Indeed, it sometimes escapes destruction altogether and persists as a protruding bleb. Its final rupture may be precipitated by stooping, sneezing, crying, coughing or bodily exertion, or from compression of the eyeball by an attack of blepharospasm.

The *subjective symptoms of perforation* are sharp, severe pain and sudden escape of hot fluid (aqueous humor) from the eye.

The objective symptoms of corneal perforation are conspicuous; these are minus tension, obliteration of the anterior chamber, the iris in contact with the posterior surface of the cornea, or its prolapse and incarceration in the corneal opening. The lens also moves forward and rests in contact with the cornea. Perforation is usually followed by a subsidence of irritative symptoms, and it marks the termination of the substance loss and the beginning of the regressive stage. On the other hand, perforation may be followed by intraocular infection and other disastrous results. Immediately, one may observe an intraocular hemorrhage, dislocation or expulsion of the lens; more or less remotely, fistula of the cornea, corneal ectasia and flattening, glaucoma and panophthalmitis. Perforations which occur spontaneously from the forces just mentioned are attended by more extensive prolapse of the iris than when they happen otherwise. If extra-pupillary, the opening is blocked by the valve-like action of the prolapsed iris, which becomes solidly incorporated in the walls of the ulcer and there remains as a permanent part of the resultant scar, producing a condition known as *leucoma adhœrens.* In large perforations, situated outside the pupillary area of the cornea, the iris may protrude above the surface of the cornea and a hernia of the iris results (*iridocele*). When corneal destruction is complete (a small zone at the limbus always remains intact), *total prolapse of the iris* follows.

The effect upon the *shape of the pupil,* in anterior synechiæ, depends upon the site of the perforation and the extent of the prolapse of the iris. In large perforations near the corneal periphery, the deformity of the pupil is greater than when the pupillary area of the cornea is alone involved; it may escape prolapse and distortion altogether when the perforation is small and situated at the pupillary center. However, even in this event, the lens, as a result of the obliterated anterior chamber, moves forward and rests in contact with the posterior opening in the cornea. As a consequence, an anterior capsular cataract is produced. When the perforation is large and occupies the center of the cornea, the entire pupillary margin of the iris may become adherent to the walls of the ulcer, producing what is known as *occlusio et seclusio pupillœ,* a serious condition often fatal to vision, if not ultimately destructive of the eyeball.

In the cicatrization of corneal ulcers, accompanied by prolapse, the incarcerated iris is generally included in the scar tissue. The changes which occur in that part of the iris thus exposed are described by Fuchs, as follows: "It is converted by inflammation into a sort of granulating tissue so that the prolapse soon loses the color of the iris and becomes grayish-red. Subsequently there develops from the proliferating tissue of the iris cicatricial tissue, which first becomes visible under the form of isolated gray bands. By the contraction of these latter, constrictions are formed upon the surface of the prolapse. As the formation of the cicatrix proceeds, these bands become broader, fuse together, and render the prolapse constantly flatter and flatter. Hence in favorable cases the process terminates in the formation of a flat cicatrix situated at the level of the rest of the cornea, and at the site formerly occupied by the bulging prolapse."

The most favorable termination of extensive corneal ulcerations, with their accompanying prolapse of the iris, is in *flat* cicatrices. Large perforations sometimes heal with considerable contraction of the scar tissue and the cicatrix appears flattened in comparison with the normal contour of the cornea. It may also happen that the adjacent, transparent cornea shares in the flattening process—*applantio corneæ.* When healing is not thus accomplished an *ectatic cicatrix,* which includes the iris, develops and progressively protrudes, terminating in the formation of a *staphyloma corneæ.*

When the cicatrization of the cornea following perforation is incomplete, there remains a permanent opening—*fistula of the cornea.* The presence of fistula is determined by decrease in the depth of the anterior chamber, continued escape of the aqueous, minus intraocular tension and the presence of a small, dark spot near the center of the cicatricial tissue. Persistent fistula of the cornea means destruction of the eye, indicated by the latter becoming softer and softer, with gradual flattening of the cornea and, ultimately, detachment of the retina. In other cases, these fistulous openings alternately close and open anew at varying intervals and, as a result of a severe intraocular inflammation or hemorrhage the eye atrophies and complete blindness results. Finally, *atrophy of the eyeball* sets in and there is a *gradual* diminution in its size, which differs somewhat from true *phthisis bulbi,* in that shrinking of the globe is rapid (from five to eight weeks) and more complete than in the latter condition. In phthisis bulbi symptoms of irritation are usually absent and, despite the fact that it results from panophthalmitis, sympathetic inflammation rarely develops. *Phthisis corneæ* refers to almost complete destruction of the cornea without appreciable diminution in the size of the rest of the eyeball.

In addition to the above are the following sequelæ, equally or more disastrous to vision: intraocular hemorrhage, luxation of the lens, irido-cyclitis and panophthalmitis.

Intraocular hemorrhage is the result of a sudden decrease of tension by spontaneous perforation or, when prior to a sudden but retarded perforation, increased intraocular tension has existed. If, added to the above, there are alterations in the blood-vessel walls, the tendency to intraocular hemorrhage is greatly increased. In large perforations, the hemorrhage may be expulsive and of alarming severity.

Luxation of the lens occurs when the sudden forward movement, incident to perforation, causes great stretching or rupture of the zonula of Zinn; or the lens may be entirely extruded from the eye in cases of large perforation.

Irido-cyclitis or *panophthalmitis* occurs as a result of the extension of virulent and destructive suppurative processes to the deeper parts of the eye.

The *clearing of corneal cicatrices* is greatly influenced by the extent of the ulcerative process and the age of the individual. Circumscribed and superficial cicatricial deposits undergo greater absorption than those which are deep and diffuse. Owing to the softness of the corneal tissues and the active lymph circulation therein, corneal cicatrices in young subjects are more readily absorbed than are the corneal scars of adults and in the aged. Cicatrices due to corneal perforation of all sizes at all ages remain practically unchanged.

It is apparent, therefore, that many factors affect the *prognosis* of the suppurative keratitides, both as regards vision and the integrity of the eyeball. As we have seen, it is influenced by the age of the patient, the resisting powers of the corneal tissues, the location and extent of the involvement, the characters of the infecting micro-organisms and whether perforation or other sequelæ develop.

The *treatment of corneal ulcer* must be governed by the exigencies of individual cases. We must be guided in the selection of curative measures by the site, variety, source of infection, offending organism, stage and other conditions complicating the ulceration.

Small, superficial, stationary corneal ulcers may be regarded as ambulant cases; patients with extensive, progressive or complicated ulcer of the cornea should be placed in a hospital where they can be more successfully treated. Simple corneal ulcers, and especially those accompanied by considerable discharge, may be treated by substituting dark glasses or goggles for bandages, but when relief from mechanical irritation caused by the action of the lids is sought, or support to the weakened or perforated cornea is demanded, the bandage becomes

indispensable. Occlusive bandages should be applied with care so as to provide sufficient and uniform pressure to afford the necessary protection and support.

In the treatment of recent cases a careful inspection of the involved area should be made to determine the presence or absence of foreign bodies, to determine the condition of the conjunctiva and lachrymal sac, and to make a bacteriologic investigation of both organs. Simple ulcers will usually respond promptly to the instillation, four or five times daily, of such mild antiseptic lotions as mercury cyanide 1 to 3,000, 1 to 5,000 formalin or 1 to 5,000 mercuric chloride. Dionin, 3 to 5 per cent., and moist warm compresses are effective adjuvants. Torpid ulcers require the application of stimulating agents, such as finely-powdered calomel, iodoform or aristol (powder or salve), or a 10 per cent. dionin ointment.

More marked cases of infection call for more drastic measures, of which, in addition to the agents just mentioned, the most popular is scraping the necrotic tissue, followed by cauterization with 80 per cent (or even pure) phenol, pure nitric, lactic or trichloracetic acid. Tincture of iodine is another remedy which, either alone or in conjunction with carbolic acid, possesses unquestionable efficacy and, by many, is given the preference over those just mentioned. Dionin, owing to its analgesic and lymphagogue action, is a remedy which exerts marked beneficial effects. Arnold Lawson strongly advocates the use of quinine, for which he claims powerful curative properties even in the severest types of corneal ulcerations. A solution of the sulphate is prepared by adding sufficient sulphuric acid to hold the salt in solution and then reducing the mixture by water to a 1 per cent strength. He recommends that this be used to soak the eye for five minutes, four or five times daily, as well as irrigation with the same solution several times each day. Stronger solutions are painful and no more potent. This treatment is generally followed by improvement in three or four days.

Corneal ulcerations from pneumococcal or diplo-bacillary infection may be effectively combatted by a 20 per cent. solution of zinc sulphate, applied with a cotton-tipped applicator. Especially in diplo-bacillary ulceration of the cornea, this is the remedy *par excellence* and has proven so effective that its action is almost specific. One application will sometimes suffice to bring about the regressive stage.

The enthusiasm for subconjunctival injections, while not as great as formerly, indicates a method of treatment which, in extreme cases (serpent ulcer in particular), is attended by appreciable results, yet the reaction is occasionally very pronounced. For subconjunctival

injections (preceded by instillations of a local anesthetic) the most effective are 5 to 10 minims of a 1-2,000 sublimate or mercury cyanid solution combined with a 1 per cent. solution of acoin. When given in this combination the pain is inconsiderable. The local reaction may be controlled by cold or hot fomentations. Some authorities believe that mercury salts possess no advantage over 5 or 10 per cent. salt solutions.

With reference to the use of atropine and miotics, Nuel says that the employment of atropine can seldom be dispensed with. The indication for its use is given by the signs of congestion of the iris —ciliary pain, contraction of the pupil and sluggishness of the iris tissue. Dilation of the pupil immediately alleviates ciliary pain and causes improvement in the appearance of the ulcer. Furthermore, the drug prevents the formation of posterior synechia and breaks recent adhesions; after healing of the ulcer synechiae frequently impair vision and produce glaucoma. The difficulties that may result from the presence of large anterior or posterior synechia must not be forgotten. Every time that atropine fails to dilate the pupil it tends to render the eye glaucomatous, and in such a case should not be employed. In such a case the writer would prefer instillations of eserine or, rather, of pilocarpine, which is less painful, three or four times a day. Some authors recommend miotics in all cases of corneal ulcer. This is done for the purpose of diminishing the pressure in the anterior chamber, especially when there is danger of perforation. Instillations of miotics are disliked because they all (especially eserine) produce ciliary pain and favor the formation of synechia by maintaining the iris closely against the crystalline lens.

The employment of the *actual cautery* may become necessary as a means of combating corneal ulcerations which have resisted other methods of treatment. Its use requires care, deftness and judgment and, as its application is always followed by a scar, the pupillary area should either be avoided altogether, or but very lightly touched, and then only when the progress of the process in this area is pronounced. Since the infective organisms do not spread deeply, but laterally, and are most abundant at the spreading margins of corneal ulcers, either fluorescein or methylene-blue or violet should be instilled prior to cauterization, since the stain clearly defines the progressive margins. Applications of powdered cocaine will render the use of the cautery almost painless. The resultant eschar (which acts as a foreign body) produced by the carbonizing effect of the galvano-cautery should be removed by cotton wrapped on a probe and saturated with a 20 per cent. solution of sulphate of zinc. In the more formidable appearing

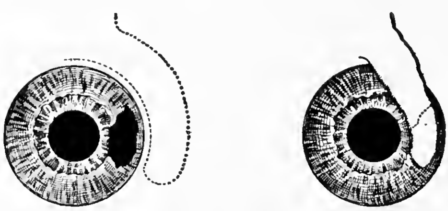
ulcerations, serpent ulcer, for example, the necrotic tissue may be removed by a small curette before the cautery is applied.

Paracentesis of the anterior chamber is a simple procedure of value when perforation is imminent or intraocular tension has risen above normal. When hypopyon is excessive, with or without impending perforation, the keratotomy of Saemisch should be considered, despite the fact that it is frequently followed by extensive incarceration of the iris in the incision. Conjunctivoplasty, as proposed by Kuhnt, affords an effective means of combating the virulent forms of corneal ulcerations.

When perforation of the cornea has occurred, every effort should be made to minimize or prevent prolapse of the iris, and to secure a firm and flat cicatrix. An old iridic prolapse should not be disturbed; recent prolapses should be excised.

Appropriate constitutional treatment should be instituted when suppurative keratitides are in any way dependent upon a general disease.—(J. D. L.)

Conjunctivoplasty in corneal ulcer. In 1876, Schöler (*Berlin. Klin. Wochensch.,* 1884, p. 421) recommended transplantation of peduncu-

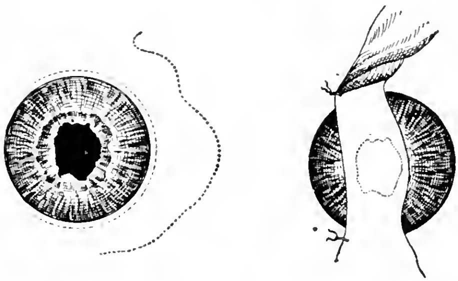


Method of Making a Tongue-like Conjunctival Flap, in the Treatment of Corneal Ulcer. (Kuhnt.)

lated conjunctival flaps in the radical treatment of corneal ulcers with and without iris prolapse. Kuhnt (*Vorschlag einer neuen Therapie bei gewissen Formen von Hornhaut-Geschwüren,* Wiesbaden, 1884) also advised this mode of treatment, particularly in large prolapses of the iris. Both of these authorities state that the procedure is beneficial for the removal of local pain. De Wecker (*Annales d'Oculistique,* 1894, CXII, p. 293) has made use of the method for the closing and the protection of large corneal wounds. It is of value by closing the defect with solid tissue after the excision of the prolapse, and protecting the eye from extensive synechia. Weiss (*Archiv für Augenheilk.,* 1896, XXXIII, p. 311) speaks of its usefulness in this connection. It is said to be of value in perforated ulcers and loss of corneal

substance from other causes, though Knapp (*System of Diseases of the Eye*, Vol. III, 1898, p. 833) wisely states: "An aseptic corneal ulcer, I think, needs no conjunctival flap to cover it, and whether it is prudent to cover an infected ulcer, however carefully sterilized, has, to my mind, to be proved by further clinical observation." Weiss (*Archiv für Augenheilk.*, Vol. XXXIII, p. 314) on the contrary, asserts that such misgivings have proved unfounded. Meyer (*Bericht der Ophthal. Gesell*, 1892, p. 192) and Herman Snellen (*Report of the VIII Internat. Ophth. Con.*, Edinburgh, 1894) have written upon its advantages.

Ball (*Modern Ophthalmology*, 1904, p. 353) says that penetrating wounds of the cornea should be covered with a conjunctival flap in order to prevent secondary infection. He tells us that "If the wound is situated at the periphery of the cornea, the simplest method of covering it will be to loosen the conjunctiva all around the cornea, and



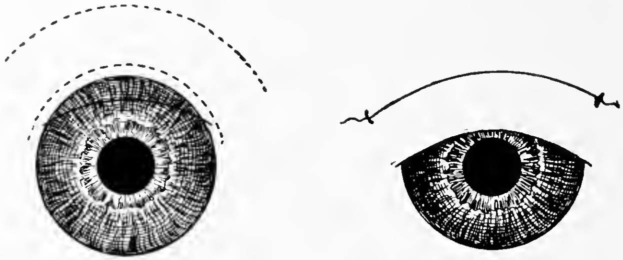
A Centrally Placed Conjunctival Flap for Corneal Ulcer. (Kuhnt.)

insert a purse-string suture. This is to be tied and is left in situ for several days. If the wound involves the centre of the cornea, a loosening of the conjunctiva with the excision of a suitable area of this membrane, will be required. In simple, clean-cut corneal wounds, this method of treatment may not be necessary. In lacerated wounds it should be adopted."

The procedure consists in excision of the prolapsed portion of the iris in such a way as to leave, for example, the thinned and ulcerous area of the cornea directly opposite the coloboma and "free from any" synechial attachment. All overlying epithelium in the flat variety is to be curetted free. If the epithelium is more abruptly and perpendicularly placed, union of the parts may be facilitated by judiciously scraping the thickened massings as thin and as flat as may be thought best in each individual instance.

Local analgesia is all that is necessary for the procedure.

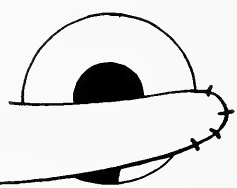
A broad, tongue-like flap is dissected from the bulbar conjunctiva which is nearest to the colobomatous area, with a pair of scissors, in such a way that the edge of the flap approximating the cornea is parallel with the limbus. This is shown in the figure. The width of the flap should be made about twice the width of the ulcer.



Kuhnt's Third Method of Making the Conjunctival Flap to Cover the Corneal Ulcer.

The flap is freely dissected free, and the still-attached base is carried sufficiently far back, broadened and shaped so that it may be easily turned into position over the ulcerous area without any degree of strain or of tension upon the flap.

In centrally placed ulcers, the flap is best made from both above and below in such a way as to cover the affected corneal area in a vertical manner as shown in figure, there usually being a greater abundance of conjunctival tissue in these situations: There is also less traction from the exterior muscles of the eyeball. Both Weeks (*Trans.*



Arrangement for Sutures in the Conjunctival Flap, for the Surgical Treatment of Corneal Ulcer. (Kuhnt.)

Am. Ophthalm. Soc., 1910) and Oliver (*Trans. Am. Ophthalm. Soc.*, 1910) have made use of the method.

A third plan employed by Kuhnt in order to cover a corneal wound, is well shown in the illustration.

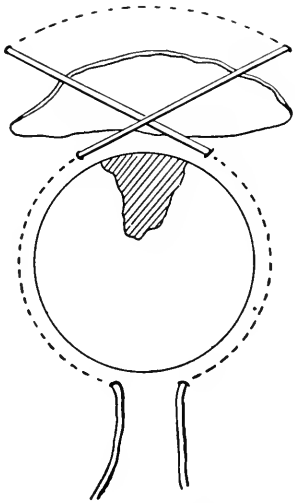
Care should be taken not to excise too much conjunctival membrane, as the movements of the eyeball may be interfered with.

Arranging the flap in proper position, its apex (of the tongue-like variety) is fastened to the bulbar conjunctiva on the opposite side of the cornea, so as to cover the ulcer. The apex of the flap is sutured

into position by several fine stitches, taking care that the curved ends of its apex do not curl out of place (see figure). The other two types are similarly stitched into proper positions. If there be an undue tendency of the flaps to curl upon their sides, they may be held down by a couple of laterally-placed sutures, taking care never to encroach upon the corneal membrane.

As a rule the sutures are apt to cut out in twenty-four to forty-eight hours; but not infrequently the flaps will have laid themselves into correct position by that time.

The denuded area in the conjunctiva from which the flap has been taken may be either left to heal of itself; or, if there is any undue

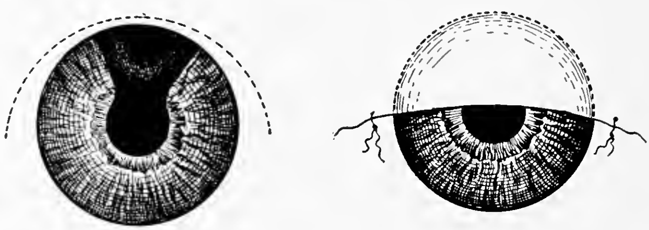


Shape and Position of the Conjunctival Flap in Front of the Coloboma. This device may also be resorted to in marginal ulcer of the cornea.

tension, a series of fine incisions in the still-attached portions of the membrane may be made. These cuts are best put into those positions which may be deemed most advisable in each individual case. Some surgeons prefer to draw the exposed area together with a number of fine, loosely-placed sutures.

After the procedure, both eyes should be so bandaged that all ocular movements are prevented, thus insuring better position of the flap. Care should be taken during the application of the bandage—particularly the first one—to see that the flap is evenly placed and that it is not curled nor twisted. If there is any such tendency, the flap should be carefully reset, by any plan of cutting and suturing, that may seem best under the circumstances. The bandage should be

changed daily, and the field of operation should be gently cleansed and kept free from all contamination and injurious secretion. The double bandage should not be changed to a single one for at least seventy-two hours after the operation. The flap is quite apt to become swollen during the first few days, gradually flattening and smoothing down to a normal condition. It should not be separated from its attachments until the parts are free from all inflammatory reaction; or, better, when the healing process has fully taken place. The amount of separation which is readily accomplished with the aid of a pair of sharp, curved-on-the-flat scissors, must be regulated in each individual case. The figure exhibits the shape and situation of such a flap placed before an iridectomized area.



Conjunctival Flap Over Corneo-scleral Break.
This plan may be utilized in corneal ulcer at the limbus.

Kuhnt (*Bericht der Ophthalm. Gesell.*, 1885, p. 219) has also resorted to this expedient, and advises the use of non-pedicled conjunctival flaps implanted over carefully cleansed ulcers of the cornea, with happy results both as to the healing of the ulcerous area and the prevention of iris prolapse.

In prolapse of the iris da Gama Pinto (*Klin. Monatsbl. für Augenheilk.*, 1887, Bd. XXV, Jan., S. 1) excises the protruding portion of the membrane, and with a blunt probe presses a non-pedunculated piece of conjunctiva into the corneal wound so that the two raw surfaces become approximated. Valude recommends da Gama Pinto's method of procedure. He first disengages the iris tissue from the lips of the corneal wound. Stellwag von Carion has given a thorough review of the subject. He thinks that large flaps should be employed by reason of the free motility of the eyeball. He says that one of the great hindrances to success is the desquamation of the epithelial covering and the development of granulations.

In wounds of the sclero-corneal region, Nuel speaks well of the plan of making a procedure which carries a conjunctival flap over the ruptured area. The accompanying sketch shows the lines of insertion of the suture.—(C. A. O.)

The *Ophthalmic Year-Book* (1910-1913) gives useful abstracts of the most practical papers on the corneal ulcer in general.

Rosenhauch (*Klin. Monatsbl. f. Augenhlk.*, p. 257, 1909) verifies the observations of Tschirkowsky, mainly that the staphylococcus aureus sarciniformis produces corneal ulcers with a tendency to progress deeply, forming a sequestrum.

Gram-negative bacilli, aside from the Morax-Axenfeld and the Petit, have rarely been found causing hypopyon ulceration. Cases due to Friedlaender's pneumobacillus, the influenza bacillus of Pfeiffer, the bacillus pyocyaneus, and a proteus-like bacillus have been reported. Rosenhauch reports a case in which the cause was an unknown Gram-negative bacillus resembling the Friedlaender bacillus, the pyocyaneus and bacillus coli, but differing from them by its cultural behavior. An unknown Gram-negative diplococcus allied to the micrococcus catarrhalis was discovered by Leber in a case of marginal infiltration associated with blennorrhea. In another the cause of a deep ulceration which destroyed the cornea was found to be the pyocyaneus.

Specific serum therapy of corneal ulcer has made little progress. Roemer's opinion (*Deutsch. Med. Wochenschr.*, p. 2148, 1909) of his own serum has undergone great change, for he now claims only that it is prophylactic, though he was formerly satisfied with its results in fully developed cases. He has treated forty cases in the last two years. As most of them came too late, on the third or fourth day, the results were bad. He recommends that the general physician give an injection of the serum, and send the case to the clinic. He would dust the ulcer also with the powder, and inject the serum into its advancing border. But Kuhnt warns against this practice, having seen disastrous results follow local injection. Schirmer, in ten cases saw no improvement follow its use, although he proved its activity in animals. Zimmerman cured twenty-four out of twenty-eight cases by the use of antidiphtheritic serum, selecting for the treatment only those cases which had proved rebellious to local therapy. He saw no harm result in any case. Improvement is noticed after the third injection, or not at all. It is not so effective in old patients. Teulières also employed this serum with success.

The statement of Fuchs (*Wien. Klin. Wochenschr.*, No. 1, 1909), that serpent ulcer, if treated early is a benign affection, receives support from the reports of cures following a great variety of remedies. Donovan urges the superiority of the electro-cautery; Marquez the use of atropin; Valenti recommends an ointment of picric acid 2 per cent.; Wirtz and Hagemann, zinc iontophoresis; Higbee, a 5 to 10 per

cent solution of lysol; and Peters, dionin and boric acid. Berens saw a remarkable cure of corneal involvement in gonorrheal ophthalmia, under dionin. Terson uses the salicyl-arsenate of mercury in corneal ulcers and infected wounds in place of mercuric chlorid, finding it less irritating.

Walker (*Ophthalmoscope*, p. 740, 1909) writes upon the operation of kerotomy, devised in 1886 by his father. Since that date it has been tried in 4,000 cases of corneal disease. A series of punctures is made with a broad needle. It is thrust into the sclera just behind the limbus; the cut is made obliquely but parallel to the plane of the iris. In severe cases the punctures are made about as far apart as the width of the needle and all around the cornea. He considers the operation superior to the Saemisch in that there is no danger of causing anterior synechia, iris prolapse or cataract, and it has no bad effect upon subsequent vision. The operation is of value in all kinds of acute and chronic corneal disease. The results in chronic eczematous cases are especially brilliant. No case of infection of the deeper parts has followed the operation. The good effects of the procedure he attributes to the relief of congestion, the removal of toxins, and the substitution of new blood with its immunizing and healing factors.

Löwenstein's admirable paper (*Klin. Monatsbl. für Augenheilk.*, Aug., 1910) on the *bacteriology of* corneal ulcer is reviewed (*Ophthalmic Review*, Dec., 1910) by Bishop Harman. The rôle of the pneumococcus in the production of hypopyon ulcer has been established by the work of many, but Löwenstein suggests that variation in the frequency of infective causes may be found for corneal ulcers, even as it appears to be for conjunctivitis.

In England and America the Koch-Weeks bacillus is a very frequent cause of conjunctivitis, whilst in Germany it is less common. Of 600 cases of conjunctivitis, Löwenstein found that bacillus only once. It is rarely found in Western Germany and still less often in Central and Eastern Germany.

In the exciting causes of corneal ulcers he finds a relative excessive preponderance of one organism.

Of 131 cases seen in two years, the bacterial findings, by smear and culture, proved to be as follows:—

70 cases pneumococcus (3 mixed with diplobacillus).
21 " diplobacillus.
1 " streptococcus.
1 " bacillus fluorescens.
1 " bac. pyocyaneous.
1 " an actinomycosis.

In 36 cases no organisms other than staphylococci and xerosis bacilli were found.

On the clinical appearances of pneumococcal infections he notes that almost always the ulcer was a typical ulcus serpens. The diagnosis of the organism was best made by smears made from material removed from the edge of the ulcer. Smear preparations were frequently more characteristic than cultures, for in fluid media the polymorphism of the organism was marked, a whole series of forms from diplococci to streptococci being frequently present. The distinctive hemolysis reaction described by Schottmüller (*Münch. med. Wochenschr.*, 1903, No. 21, v. 22) did not prove satisfactory in his hands.

He notes also that in several cases pneumococci that produced most distinctive corneal ulcers in man did not prove noxious to animals.

The sex and occupation of patients appear as follows: Women, 22; men, 48. Of all only fifteen were under forty-five years of age. Twenty-four were coal or stone workers, 2 iron workers, 10 followed injuries from twigs, 7 from corn or grass blades. In only eighteen was there no history of injury. Notwithstanding this it was evident that injury did not play a principal part in the causation seeing how common was injury in younger subjects without serious sequelæ.

Infection of the lachrymal sac was always looked for, but it was only manifest in thirteen cases. The presence of the pneumococcus in the healthy conjunctival sacs of the laboring classes of Prague was found to be abnormally frequent; as many as 30 per cent. harbored pneumococci or streptococci.

These findings indicated that neither injury nor organism together, but some third factor—a reduced tissue resistance—was necessary to the production of the ulcer.

For the most part these ulcers were treated with the galvano-cautery, the application being made to the spreading edge. Several cases were treated by puncturing the anterior chamber and extracting the coagulum. In one case the operation was performed seventeen times, the eye was saved, and after iridectomy fingers could be counted at 3 metres.

Iridectomy was performed for secondary glaucoma or, more frequently, for optical purposes in forty-five cases. Nine eyes were a total loss.

Six of the author's cases were in children, but the symptoms were not found to be of a more severe character than in adults; in this the observations differ from those recorded by Fuchs.

Of diplo-bacillary ulcers, it is noted that on certain counts a clinical distinction can be made from the pneumococcal ulcer. The diplobacillary ulcer is shallower, has a uniformly rounded margin, the edge is not excavated, and it has a yellowish color; the floor is covered with débris. In twenty-one cases only five persons were younger than forty-five years. Eight only had a traumatic history. Once the lachrymal sac was infected and the discharge therefrom showed many pneumococci whilst the ulcer smear was as rich in diplobacilli.

In the treatment of these ulcers it was found that oxycyanide of mercury 1 to 5,000 and zinc sulphate 1 to 100 were equally efficacious. Since the bactericidal powers of these solutions is feeble, it is concluded success arises from their reaction on the tissues.

Macnab (*Ophthalmoscope,* p. 629, 1910) discusses at length the bacteriologic diagnosis of organisms found in corneal ulcers. In obtaining material by scraping the ulcer it is very important not to disseminate the infection, and to follow the scraping of the infiltrate by the proper treatment. The eye should be cocainized and fixed, the lids held apart by a speculum and the surface flushed with normal salt solution. The densest part of the lesion is then to be scraped with a platinum spud, and the material thus obtained inoculated on a tube, and some rubbed on a clean slide. Loeffler's blood-serum, faintly alkaline and fractionally sterilized at 60 c.c., is recommended as a culture medium. Wirtheim's serum agar, especially if made with ovarian cyst fluid, is better for the gonococcus and Koch-Weeks bacillus.

In the majority of cases the Gram stain will settle the diagnosis. The modification recommended is: 5 per cent. aqueous solution gentian violet, 88 parts; absolute alcohol, 10 parts; anilin oil, 2 parts.

After fixing in a flame, stain with the above for thirty seconds, wash with water and fix the stain with Gram's iodine solution. Decolorize in alcohol, wash in water and counter-stain with neutral red.

The bacillus pyocyaneus, responsible for one case in Löwenstein's list, is not the harmless saprophyte it was once supposed. Mauersberg (*Zeitschr. f. Augenheilk.,* p. 299, 1910) has collected twenty-four cases and reports one additional case of his own, and still other cases are reported by Leber and Salani. The latter finds that these cases are distinguished by their rapid course, great corneal infiltration, large hypopyon, and the cheesy, greenish pus covering the corneal ulcer. They demand prompt resort to the cautery or corneal incision.

Wirtz (*Klin. Monatsbl. f. Augenhlk.,* p. 89, 1910) experimenting on rabbits found that zinc iontophoresis with a current of two milli-

amperes continued two minutes either killed the germs or so lessened their number and virulence that antibodies could overcome them. Zahn reports a series of thirty-nine corneal ulcers treated by zinc ionization. Of seventeen serpent ulcers (pneumococcus) fourteen healed completely, and in three cauterization had to be resorted to. The ten cases of diplobacillus ulcer all healed after one to four applications, some with dense opacities. Six cases of dendritic ulcer healed with thin opacities after one or two applications. Six cases of ulcer of unknown origin all healed rapidly after one application. Jones (*British Med. Journ.*, p. 526, 1909) reports four cases in which zinc ionization arrested the progress of Mooren's ulcer. For the positive electrode he uses a loop of zinc wire, armed with a fine web of absorbent wool dipped in a 1 per cent. solution of zinc sulphate. The current is turned very gradually to 1 or 1.5 milliamperes, continued three or four minutes, and gradually turned off. The zinc solution is instilled for a day or two afterward.

The fractional sterilization of serpent ulcer has been practised by Weekers (*Bull. de la Soc. Belge d'Ophtal.*, p. 70, 1910). The cautery tip brought to red heat is held near but not in contact with the cornea for five or six minutes on two or three separate occasions. The surface of the ulcer dries and may be moistened with physiologic salt solution. Other parts of the cornea remain normal. A few hours later the surface of the ulcer becomes covered with a whitish membrane and the hypopyon is larger, showing an access of leucocytes. Eleven cases were treated successfully by this method, with hot compresses, atropin and argyrol. The treatment of corneal ulcer by suction hyperemia is the subject of an article by Cooke. The experience at the Nancy clinic with the treatment of corneal ulcer with the hot air douche is recorded by Rozet. The air stream was well borne at a temperature of 65 to 70 C. and was followed by improvement of acute ulcerative processes within one day, while chronic processes were healed within four weeks.

From his experimental and clinical study of its action on the cornea, Cords (*Ophthalmology*, p. 140, 1910) concludes that in almost all cases scarlet-red hastened the regeneration of the stroma and the process of cicatrization, although it is not antiseptic. It is to be recommended in clean and especially deep corneal ulcers, and where there is a small iris prolapse or a fistula. In his experiments he removed with a trephine a portion of epithelium or deeper tissue from each cornea of the rabbit, treated one eye with scarlet-red, and the other without, and after a certain time removed both eyes for microscopic

examination. In the eye treated with the scarlet-red the epithelium began to regenerate first, and there was quicker regeneration of the true corneal tissue. He reports ten cases, including different varieties of corneal ulcer, in almost all of which it hastened cicatrization.

The use of picric acid in 2 per cent. ointment in the treatment of serpent ulcer is the subject of a communication by Cecchetto. The ointment was applied twice daily to the ulcers and soon caused the disappearance of micro-organisms, resorption of hypopyon, and vascularization and repair of the lesion with a minimum scar.

The instillation of fresh rabbit's bile for serpent ulcer has been tried by Luppino. He finds the bile is not innocuous to the eye but causes a sharp, burning pain, edema, a slight mucous discharge and haziness of the cornea. In ulcers of medium intensity, however, it has a powerful influence for cure. Dean believes that he has saved many cases of hypopyon keratitis from need of incision by use of hydrogen peroxid applied to the ulcer on a cotton swab held to the surface for a few seconds. Dunn reports the best results in a series of cases with this treatment for crescentic ulcer. Ewing has used the mild caustic to which he previously called attention in cases of hypopyon keratitis with favorable result. Adam has advised the use of blenno-lenicet for gonorrheal ulcer.

In a case of infection by bacillus pyocyaneus, Verderame saw enormous chemosis of the bulbar conjunctiva, which overlapped the cornea 3 to 5 mm.; and a yellowish-gray membrane covering the palpebral conjunctiva, removal of which caused slight bleeding. Two days later corneal infiltrations appeared at the periphery and developed into ulcers which coalesced, covering almost the whole cornea. There were hypopyon and sero-purulent discharge. The corneal ulcer had not undermined edges, but the surface was covered with a necrotic tissue. It healed without perforation. Pagenstecher saw a corneal infection following abrasion with a bulrush, which rendered enucleation necessary. He found what at first seemed to be bacillus flavescens, but by prolonged cultivation was proved to be bacillus pyocyaneus.

A case of corneal ulcer due to the diphtheria bacillus is reported by Buchanan. A man of sixty-nine came with an eye sore for some weeks. The lids and conjunctiva were congested, but not thickened, or showing false membrane. The ulcer extending over the lower-third of the cornea was grayish-yellow, slightly elevated, with two or three flecks looking like blood-clots; and blood was seen in the anterior chamber. The appearance suggested a diphtherial patch. The bacilli were found in smears and culture, and proved virulent to

the guinea-pig. The patient was given 4,000 units of diphtheria antitoxic serum, and four days later showed merely a cicatrized leucoma. Traquair saw an ulcer following injury in a miner fifty-eight years old. On the fifth day the oval yellow area of sloughing tissue measured 6 mm. by 4 mm. Healing set in after a third application of zinc iontophoresis. Bacteriologic studies showed the presence of streptococcus mucosus. An organism closely resembling this seems to have caused ring ulcer in a case reported by Terlinck. The patient suffered from chronic lachrymal obstruction.

The elaborate study of Kuffler upon an infection of the vitreous seems to connect this condition with ring abscess of the cornea, and suggests a dependence upon saprophytic infections, especially by the bacillus subtilis. Kapuscinski has collected a series of thirty-six cases from the clinic at Halle. All the children were in poor health, and fourteen out of thirty-one patients died, eleven of the deaths occurring under six months of age. Dutrow reports three cases of corneal ulcer, very resistant to treatment and chronic, in which the xerosis bacillus was found in pure culture, and he attributes to it a causative influence.

From a study of 157 cases of serpent ulcer, Gunnufsen finds it almost invariably occurs in eyes previously diseased. One hundred and twenty-nine had lachrymal disease and chronic conjunctivitis; thirteen had inflammations of the conjunctiva and lid. In 109 the ulcer followed injury. Of 101 cases tested with Schiötz' tonometer, fifty-nine showed increased tension, thirty-seven normal, and in five diminished tension had followed perforation. Gunnufsen believes that this liability to increased tension is a decided contra-indication to the use of atropin in these cases. The remedies relied on are the galvano-cautery, and peripheral opening of the anterior chamber. When perforation of the cornea is imminent, Chaillous does paracentesis and reopens the wound daily until improvement is well established.

According to Casali eserin is largely used in the clinic at Florence. After treatment of the underlying lachrymal condition, a pomade containing ½ or ¾ per cent. of eserin is placed in the eye, which is then bandaged for twenty-four hours. This is repeated until the hypopyon has disappeared, and the ulcer becomes clean. If the first application does not show improvement, other treatment is resorted to. Traquair reports a series of twenty-seven cases of purulent keratitis, twenty of which would be classed as serpent ulcer, treated by iontophoresis, which results comparing very favorably with a series treated by other methods, especially by the Saemisch incision.

Favorable results in hypopyon keratitis have been reported by John Green, Jr., from a method suggested by Wolfner and Wiener. Powdered methylene-blue is dusted over the surface and the eye bandaged for twenty-four hours.

Dauthuile, from the clinic at Lille, reports five cases, including abscess and ulcer of the cornea with hypopyon, which seemed greatly benefited by the tincture of iodin applications. Charles records a case in which an injured eye was apparently saved from complete loss from suppuration by a treatment of mixed vaccines and urotropin. Arens and Bodeewes report favorable results in hypopyon keratitis from the use of pyocyanase.

The publication of Weekers' method for sterilizing infected corneal ulcers by heat has induced Bourgeois again to call attention to his own experiences. He has used it in all cases of corneal ulceration, and claims the results obtained are truly remarkable. He uses the rubber balloon for heated air employed by dentists. Holding the tube tip upward in an alcohol flame, brought close to the patient's eye, the air is drawn three or four times through the hot tube, and then expelled against surface of the ulcer, which soon becomes white. The process may be repeated, and the healthy cornea around the ulcer also heated. The application is made under cocain anesthesia.

R. Kaz (*Klin. Monatsbl. f. Augenheilk.*, March, 1912) emphasizes the excellent effect of eserine in various diseases of the cornea, with the assertion "in iritis atropine, in keratitis eserine." For ten years he has continued to treat affections of the cornea with eserine 0.01, xeroform 0.06, vaseline from 2.00 to 3.00, with very good success. Trachomatous pannus, scrofulous and torpid corneal ulcers from malnutrition, marginal infiltrations and ulcers, blennorrheic ulcerations and hypopyon-keratitis heal much better than under atropine. Kaz recommends in corneal ulcer eserine from 1/3 to 1/2 per cent., in iritic symptoms atropine 1/5 per cent. Especially in old patients atropine is to be avoided, on account of its tendency to increase the intraocular pressure and the tension of the cornea.

W. H. Bailey (*Medical Press*, Mar. 20, 1912) calls attention to a compound named allantoin, which he terms a new cell proliferant. Its action is not that of an antiseptic; so far from that being the case it actually encourages the growth of organisms, but its chief use is that it encourages the proliferation of tissue cells. Bailey particularizes the case of a small corneal ulcer, which, after cauterization and the application of various remedies, did not get well. Drops of allantoin caused a marked improvement. He mentions several similar cases,

and explains the beneficial action of the drug by its causing the cornea to receive extra nourishment. He considers that the drug is well worth a trial in all cases of long-standing keratitis, and possibly scleritis.

Cornea, Ulcus serpens of the. See **Cornea, Serpent ulcer of the.**

Cornea, Uninfected ulcer of the. See **Cornea, Simple ulcer of the.**

Cornea, Vaccination ulcer of the. When this condition is due to primary infection, the clinical picture does not differ from that of an ordinary papular ulcer. The destruction is superficial and resolution occurs without leaving any evidence of loss of substance. Secondary ulcers, occurring at a later stage, may occupy the central portion of the cornea; they are then likely to be deep and disc-like in shape, and followed by scars. This latter corneal condition is almost identical in appearance with *keratitis disciformis*, which, however, is observed only after herpes or traumatism.—(J. D. L.)

Cornea, Variolous ulcer of the. SMALL-POX OF THE CORNEA. Corneal inflammations and ulcers may develop as an extension from pustules situated at the limbus, but more frequently they appear independently. They may also result from endogenous infection. Prior to the advent of vaccination, variola was one of the most frequent causes of blindness.—(J. D. L.)

Cornea, Vascularization of. NEW VESSELS IN THE CORNEA. The normal cornea is a non-vascular structure and the presence of blood-vessels in it is of considerable clinical interest. Movement of the blood cannot be made out at the height of an inflammatory process, but during the regressive stage a rapid flow may be noted in certain veins. Retardation of the blood current is brought about by decrease of the inflammation. This phenomenon may be noted in cases treated with jequiritol; when its action begins, there is a noticeable fullness of the vessels and an increase in the movement of the blood. As the angiovascular condition heightens, the blood stream becomes less visible until, at the acme of the jequiritol congestion, movement of the blood can no longer be perceived. Later, as the inflammatory symptoms subside, a blood current is again visible. In some cases of iritis, the clear cornea becomes infiltrated by deep lamellar vessels, an occurrence for which there is no satisfactory explanation.

Corneal vascularization may be classified as superficial or deep, circumscribed or diffuse, but these forms frequently coexist. Their development also varies greatly; they are sometimes marked by the rapid appearances of numerous blood-vessels, while, in other instances, the vessels are few in number and slow of development. The character of the vascular supply alone frequently enables us to distinguish be-

tween the progressive and regressive metamorphoses of certain corneal inflammations. It may also indicate with considerable accuracy the prognosis and treatment of these two stages of the disease.

Clinically, it is sufficient to study corneal vascularization as *superficial* and *deep*.

Superficial new-vessels spring from the surface loops at the corneal margin, as *circumcorneal injection*. Naturally, the nearer the corneal surface, the brighter the red color and the better the definition of the vessels. In superficial vascularization the cornea is uneven, owing to the situation of the vessels beneath the epithelium. As a rule, the afferent and efferent stems of the branching superficial vessels follow separate courses. When the new-formed superficial vessels, which traverse the most superficial corneal layers, reach an ulcerative area, we may be assured that the necessary nourishment and material for supplying loss of substance is being provided and that the healing or regressive stage has set in.

Deep vessels develop subsequent to the appearance of the superficial branches and are more sparse. They spring from the deep marginal loops of the episcleral vessels and, in rare instances—especially in cicatrices—are located at different depths. The course of deep corneal vessels is usually parallel, or slightly divergent. A typical example of deep vascularization is found in keratitis parenchymatosa; however, in this disease superficial vessels are also frequently present. Deep corneal vessels have the appearance of terminating rather abruptly at the sclero-corneal margin. Their color is of a characteristic, dusky-red and the surface of the cornea containing them is more or less dull. There is, however, no unevenness, as noted in superficial vascularization. Ordinarily, the afferent and efferent vessels pursue a parallel course, and towards the corneal center they are connected by a short arch, so as to form a loop.

As stated, the regressive stage of corneal ulceration is frequently marked by vascularization, yet it may indicate the opposite (progressive), as in keratitis parenchymatosa. It is notable, in addition to this exception, that there are no reparative vessels in ulcus serpens and that the presence of new-formed vessels in pannus does not indicate either a progressive or a regressive inflammatory condition.—(J. D. L.)

Brückner (*Archiv für Augenheilk.*, 62, p. 17, 1910) believes that the vessels at the corneal margin do not commonly anastomose, but connecting vessels may be found occasionally, even between those which are superficial and those which lie deep in the cornea or arise from the iris. In eczematous disease of the cornea the vessels appear

more quickly than after deep suppurating ulcer. The inter-lamellar deep vessels cannot be regarded as pathognomonic of parenchymatous keratitis. Deep vessels are especially liable to develop at the lower corneal margin with iritis, and they appear in cases of injury with foreign bodies.

Cornea, Vesicles on the. See **Cornea, Herpes of the.**

Cornea, Wounds of the. See **Cornea, Injuries of the**; as well as the major heading, **Injuries of the eye.**

Cornea, Xerosis of the. See **Keratitis, Xerotic.**

Cornée. (F.) Cornea.

Cornée conique. (F.) Conical cornea.

Corneitis. A form of the term Keratitis.

Corneoblepharon. ANKYLOBLEPHARON. CORNEOBLEPHARONCUS SYMBLEPHARON. Adhesion of the eyelid to the cornea. This condition much interferes with the transparency of the cornea and accordingly diminishes the eyesight of the patient or causes complete blindness. It is very seldom that such an attachment is confined to the cornea and the border of the lid; as a rule, the formation of scar tissue extends up to the transitional fold. It is, indeed, possible for the lid edges to be also adherent, so that the space between the lids is almost or completely obliterated and the eyeball quite invisible. In this event the eyeball itself undergoes degeneration. The sympathetic irritation caused by dragging on the lids and on the swollen eyeball may injure the other eye as well and lessen its usefulness. Corneal blepharoncus occurs both on the lower and upper lids. It is caused almost always by burning or cautery.

Vossius (*Encyklopädie der Augenheilk.*, p. 207) has observed it in five out of 34 cases of burns caused by molten metal, five times out of 69 cases of burns with red-hot iron, and three out of 123 cases of cautery with lime. In the last named the scar tissue was less compact and extensive than in the metal burns. Only in cases of partial corneo-blepharoncus can the growth be successfully removed by surgical means. For a review of the *treatment* of this condition see **Blepharoplasty.**

Corneoiritis. Inflammation of both cornea and iris.

Corneosclera. The cornea and sclera taken together.

Corneoscleral margin. LIMBUS CORNEÆ. CILIARY ZONE. CILIARY REGION. SCLEROCORNEAL JUNCTION. The apparent union of those histologically similar eye-coats, the sclerotic and cornea, constitutes a fairly well defined seat of growths and other pathological changes of much interest to the ophthalmologist. The inner edge of the bevel-

like arrangement by which the sclera overlaps the cornea makes a regular groove in this tissue much like the metal rim that holds a watch-glass. To this depression the Germans give the name of *Cornealfalz,* that is, corneal setting or groove. As Baker (*System of Diseases of the Eye,* Vol. 1, p. 131) points out, the relations of the corneo-scleral junction to the structures within the eye should be carefully noted, as operative incisions are often made in this neighborhood. On examination it will be seen that the iris is attached just at the posterior edge of the bevel, so that an incision at or even a little behind the anterior edge, which appears externally as the corneal margin, must necessarily enter the anterior chamber or space in front of the iris. To enter the posterior chamber or space between the iris and the lens, the incision or puncture must be from three to four millimetres behind the external corneal edge.

The infections and neoplasms that especially attack this region will be described in detail under various headings. Here it may be said that among them are such true tumors as carcinomata, dermoids, papillomata and angiomata.

Corneotomy. A term applied by Alcorn (*Trans. Ohio Vall. Med. Assocn,* May, 1883) to evisceration of the eyeball.

Cornes des paupières. (F.) Horny growths of the eyelids.

Cornet. (F.) Tenon's capsule.

Corneule. (F.) One of the facets of the cornea in a compound eye of an insect, or other animal. See **Comparative ophthalmology,** as well as **Insects, Eyes of.**

Corn-flower. Centaurea cyanus. The juice of the flowers was formerly employed in the preparation of collyria.

Corn-starch. See **Starch.**

Cornu cutaneum. Cornu of the lids. Cutaneous horn of the lids. Horny growths on the eyelids. This peculiar disease generally involves the lower lid. It occurs in middle life, and its extirpation, with cauterization of the base, is to be advised. Epithelioma is said to be likely to follow if its spontaneous fall is permitted to occur.

According to Parsons (*Pathology of the Eye,* Vol. 1, p. 16) they are usually solitary and conical, with rounded apices. The papillæ at the base are usually hypertrophied, and extend upwards a short distance into the horn, stopping sooner in the axis than at the periphery. The essential change, however, is in the prickle-cells, which proliferate rapidly, the young cells quickly becoming horny without being shed. They thus accumulate and form the main mass of the growth. The horny cells are arranged in columns of concentric

laminæ, with similar cells irregularly placed in the interstices, cementing them together. The hair-follicles and ducts of the sweat-glands participate in the epithelial proliferation. That the condition is dependent upon epithelial, and not papillary proliferation (Unna), is shown by the growth of horns where there are no papillæ, e. g. on a cicatrix (Bland-Sutton), on the cornea of a cow (Baas), on a

Cornu Cutaneum of the Lower Lid. (Panas.)

staphylomatous pseudo-cornea (Arnold Lawson). See, also, **Tumors of the eye.**

Corocleisis. Coroclisis. Closure or obliteration of the pupil by a membrane or an inflammatory exudate.

Corodialysis. A synonym of iridodialysis.

Corodiastasis. Dilatation of the pupil.

Corodiastole. (Obs.) Dilatation of the pupil.

Coroide. (It.) Choroid.

Coromegine. Runge's name for atropine, so-called on account of its property of dilating the pupil.

Coromeiosis. Coromiosis. (Obsolete.) Contraction of the pupil.

Coromorphoma. (L.) (Obs.) An artificial pupil.

Coromorphosis. (Obsolete.) The operation of making an artificial pupil.

Coromydriasis. Mydriasis.

Corona ciliaris. The (circlet or crown of the) ciliary processes taken collectively. See **Anatomy of the eye.**

Corona conjunctivæ. That portion of the conjunctiva that surrounds the cornea.

Corona palpebrarum. The tarsus, or so-called tarsal cartilage.

Coronat's test. This rather ingenious device for the detection of feigned unilateral blindness is an arrangement of concave mirrors and (See Norris and Oliver's *System of Diseases of the Eye,* Vol. 4, p. 872) may be made of materials to be found in any optician's shop.

One of its advantages is that it does not cover the suspected person's eyes so that he may be easily watched.

The concave mirror is attached to an upright in front of which is arranged another standard perforated with an aperture which covers the head of the suspected individual. Just beneath this aperture is a rotating disc upon which some ocular wafers have been pasted. These latter are one by one brought into the right or the left of two horizontal apertures in a black plate which otherwise covers it. The axis of the mirror, inclined at a certain degree to the horizon, passes through a point that is situated between the eyes of the patient and the rotating disk, just as the plane of vertical symmetry of the apparatus corresponds to the centre of the mirror and to the middle of the distance of the two eyes. According to these arrangements, the color of the right aperture, for example, projected to the centre of the mirror, will be formed at the left and can be seen only by the left eye of the patient, and *vice versa,* which he is unaware of unless he closes alternately the two eyes.

Coroparelcysis. An operation devised by Himly involving displacement of the pupil, to remedy a partial opacity of the cornea by bringing the pupillary opening opposite a transparent part of the former. An optical iridectomy.

Corophthisis. (Obs.) A wasting disease of the eye characterized by diminution of the size of the pupil.

Coroscopy. A synonym of skiascopy or retinoscopy.

Corosystole. (L.) An old term for miosis or contraction of the pupil.

Corotomia. Iridotomy.

Corotomodialysis. Iridotomodialysis. A term formerly used to denote a form of iridotomy.

Corotomy. Any cutting operation upon the pupil; coretomy.

Corpi stranieri. (It.) Foreign bodies.

Corpi stranieri nell'interno dell'occhio. (It.) Foreign bodies in the interior of the eye.

Corpora amylacea. This is a local condition which manifests itself in foci of degeneration or amyloid concretions, having a spheric outline, and are fifteen to twenty-five micromillimetres in diameter. They are found in the prostate, the brain, the optic nerve, the chiasma, and the optic tract. Sometimes they are found as far back as the corpora geniculata externa and the optic thalami. The amyloid concretions are most frequently found in ascending atrophy after phthisis bulbi. They usually give the amyloid reactions with iodin and acids. When treated with Lugol's solution, they appear brown or violet; the surrounding tissue is yellow. When stained with Lugol's solution and

treated with an acid, they become violet. When these concretions are found in old corneal scars, the specimen has been fixed in Müller's fluid, and the section is stained with hemalum, hematoxylin-alum-carmin, they appear yellow. In the optic nerve they stain blue with hematoxylin and hemalum, and red with alum-carmin.—(J. M. B.)

Coats (*Ophth. Soc. United Kingdom*, Vol. 32, p. 119) found concretions in an eye enucleated for sarcoma of the iris. Numerous mineral-like concretions were found in the substance of the papilla. The largest was situated near the periphery on a level with the ending of the choroid, and measured about one-fourth the diameter of the disc. It was composed of a conglomeration of partly fused masses each of which had a wavy, concentrically laminated structure. The surface was nodular. A peculiarity in the case was the association of numerous corpora amylacea in the retina. Coats considers the association of the two conditions probably a coincidence. See, also, **Concretions, Ocular.**

Corpora arenacea. These are hyaline or colloid bodies (concretions) found especially in the intervaginal space of the optic nerve. See **Colloid bodies.**

Corpora geniculata. These cerebral bodies, together with the anterior *corpora quadrigemina* and the *pulvinar*, make up the primary centres for vision. See **Neurology of the eye,** as well as **Corpora quadrigemina.**

Corpora nigra. UMBRACULUM. "Soot-balls" seen in hoofed animals especially, as black, spongy, pediculated portions of the uvea that pass through the pupil into the anterior chamber of the eye, probably as a protection against too strong light. See **Comparative ophthalmology.**

Corpora quadrigemina. An intelligent description of these important optic centres is given by Mettler (*Diseases of the Nervous System*, p. 695). He remarks that these four tubercles are situated just behind and beneath the optic thalami, two in front and two behind. Beneath them is the third ventricle and the upper end of the *aqueduct of Sylvius.* On top of them rests the *epiphysis cerebri* or *pineal* gland, which in some low forms of life has all the appearance of an atrophied primitive eye. It is sometimes called the *conarium.* It contains solid epithelial tubules, an abundant blood-supply and the so-called brain-sand. This remarkable structure in several selachians and in many reptiles passes through a hole in the skull to a sense organ under the skin. In this organ we can see a cornea, a lens, a retina, and

below this a pigmental layer. In the higher forms of life it has become useless and withdrawn into the head.

Immediately in front of the pineal gland is the ganglion habenulœ, which appears to receive fibres from the olfactory field by way of the tœnia thalami.

From the anterior corpora quadrigemina arise part of the optic nerves. Thus we see three ganglia in this immediate neighborhood serving as the origin of the optic nerves—namely, the pulvinar, the anterior corpora quadrigemina and the external geniculate bodies. They all receive fibres from the occipital lobe which come by way of the optic radiations and the posterior part of the internal capsule. These are the fibres of Gratiolet.

The posterior quadrigeminal bodies receive fibres from the temporal lobe. The great development of these posterior bodies in whales leads to the supposition that they have something to do with the auditory nerve, by way of the nucleus acusticus. The maintenance of equilibrium, it must be remembered, is one of the functions probably of the semicircular canals.

The anterior lobes of the quadrigeminal bodies present a microscopic appearance resembling layers of the cortical type, according to Spitzka. Outside are optic tract fibres then a thin layer of small nerve-cells, then again some optic fibres and finally a layer of a few large cells. The posterior lobes are less striking in appearance and merely contain some small cells and one nucleus filled with a network of fine fibres. The two posterior ganglia are connected by fibres that pass over the aqueduct of Sylvius.

Lesions of this part of the brain may give rise to ocular symptoms. The tables of Weeks and Martin prove that tumors of the corpora quadrigemina furnish the highest percentage of choked disc; next in order come neoplasms of the parieto-occipital region and of the cerebellum.

The account given by Swanzy (*System of Diseases of the Eye*, Vol. IV, p. 570) of the signs and symptoms due to new growths and other lesions of this locality are quoted at length. "What the symptoms are, which hemorrhages or softenings strictly limited to the corpora quadrigemina produce, is not yet known. Such lesions are rare, owing to the fact that these organs have their vascular supply from the posterior cerebral artery, in common with the crus cerebri, the posterior part of the lateral ventricle, the optic thalamus, and the occipital lobe. It is not long ago since it was strongly held that the corpora quadrigemina were intimately connected with sight. Griesinger stated, 'If vision be intact, the

seat of the tumor can never be in the corpora quadrigemina (the intra-cerebral seat of vision).' But in 1879, Nothnagel, after a careful examination of the evidence to hand, arrived at the conclusion that a tumor might very well implicate the corpora quadrigemina without affecting vision, and the writer is not acquainted with a case of more recent date which points to any other conclusion. The following are the only two cases which lend color to the opposite view. In a case mentioned by Charlton Bastian (*On Paralysis from Brain-Disease*, p. 115), and quoted by Nothnagel, a long illness was brought to a conclusion by blindness for about fourteen days, and a patch of softening was found almost limited to the anterior corpora quadrigemina. Eisenlohr has recorded (*Neurolog. Centralb.*, 1890, p. 747) a case in which a revolver bullet lodged in the right anterior corpus quadrigeminum, and the author thinks that the blindness of the right eye, which came on five months later without optic neuritis, is to be regarded as the result of the lesion of the quadrigeminal body *per se*, or of the right colliculus anterior. But the fact that optic neuritis was found in the right eye two months subsequently, taken with the long interval between the injury and the onset of any defect of sight, seems to render the evidence afforded by the case against, rather than in favor of, the author's views. As opposed to these inconclusive positive cases, there are many negative ones, in which tumors of the corpora quadrigemina caused no blindness; while in others, where blindness was present, it was found, in the properly observed cases, to have been accounted for by the presence of optic neuritis.

Tumors of the corpora quadrigemina, or of the quadrigeminal region, especially of the pineal gland, owing to the pressure they are liable to exercise on the central gray matter of the aqueduct of Sylvius, are apt to cause loss of motion of the eyeball very similar to that of primary ophthalmoplegia; and here, then, we have a distant symptom which may render important service in local diagnosis. Nothnagel (*Brain*, July, 1889) has pointed out that vertigo, or a reeling gait, is a constant symptom of such disease of the whole quadrigeminal mass,—if the posterior part remained uninjured, disturbances of co-ordination are absent,—and is of opinion that the derangements of co-ordination are the result of the lesion of the quadrigeminal bodies themselves, and are not caused by involvement of the median region of the cerebellum, or by an attendant hydrops ventriculorum. This vertigo is not, of course, pathognomonic of disease of the corpora quadrigemina; it may occur in diseases

of the vermiform process, of the pons, of the corpus callosum, in hydrocephalus, in some large tumors of the cerebral hemisphere with great augmentation of intra-cranial pressure, etc. Nothnagel would attach a diagnostic meaning to it only when it appears as the first symptom; for then, as a rule, the point for decision will be, whether the lesion occupies the vermiform process or the corpora quadrigemina. He would advise in favor of the latter position if paralysis of the ocular nerves, especially of the third nerves, subsequently appeared. Yet, that ataxy followed by oculo-motor paralysis in both eyes is not pathognomonic of tumors of the region of the corpora quadrigemina, is shown by a case of Bruns's (*Archiv f. Psychiatrie u. Nervenkrankheiten*, 1894, 26, p. 224), in which these symptoms in this sequence were present with a tumor in the cerebellum; while in another case, in which Bruns found a tumor in the quadrigeminal region, the oculomotor symptoms preceded the static ataxy by a considerable interval. Bruns, consequently, in opposition to Nothnagel, inclines to think, that if the ataxy is the first symptom, the diagnosis is in favor of a cerebellar tumor. He formulates his views, with all reserve, on this difficult diagnostic point as follows: 1. The connection of double ophthalmoplegia with ataxy does not possess the pathognomonic value ascribed to it by Nothnagel as a sign of disease of the corpora quadrigemina, but may be found with a tumor elsewhere—e. g., in the cerebellum. 2. Possibly, if ataxy be present at the commencement and remain a predominant symptom, it may speak for the seat of the lesion being in the cerebellum; while a commencement with ophthalmoplegia, and a predominance of this symptom all through, may indicate quadrigeminal lesion. Yet this is stated with reserve. 3. Should the ophthalmoplegia continue confined to the third and fourth nerves, it seems to speak rather for quadrigeminal disease; but, doubtless, with disease in either locality the sixth nerve may also become implicated. Paralysis of other cranial nerves point to the cerebellum as the *locus morbi*. 4. Intention tremor and choreic motions indicate quadrigeminal disease. The special characters of the ophthalmoplegia in these cases are, Nothnagel states, inequality in the degree of the paralysis, especially in the early period, and inequality in the extent of its distribution. Usually a wide difference between the mobility of the two eyes can be detected, some certain movement of one globe being merely defective, while in the other it is totally annulled. In the latter stages the paralysis may be equal bilaterally. Furthermore, it is usual for only some of the third-nerve nuclei to be affected,

most commonly those related to the superior and inferior recti; occasionally the lateral movements of the eye are quite abolished, or ptosis may be the first and most marked symptom. It may also happen that the eye is almost completely motionless, as in primary atrophic nuclear paralysis of the ocular nerves; but Nothnagel has never observed in the ophthalmoplegia accompanying tumor of the quadrigeminal bodies such entire immobility of the eyes as sometimes occurs in the primary affection. Death probably takes place before its complete development. Sometimes nystagmus without paralysis of the ocular muscles has been observed. Whether an isolated palsy of the fourth or sixth nerves, with the defect of gait, can claim a diagnostic meaning in the same sense is not yet determined. With cerebral ataxy and ophthalmoplegia, the diagnosis of a lesion of the quadrigeminal bodies would not be shaken even if, some time later, hemiplegia or hemianesthesia should appear, for these latter symptoms would be explained by pressure on the cerebral peduncle. Occasionally the ocular muscles in quadrigeminal tumor cases are not paralyzed, nor even paretic. In a case of tumor of the corpora quadrigemina, Nothnagel (*Wien. med. Blätter*, 1888, No. 6-8) observed that remarkable symptom instances of which, although without autopsies, had been already recorded by some other authors (pp. 621 and 622), namely, a persistent dropping of watery fluid from one nostril—a nasal hydrorrhea. Conjugate paralysis of the upward movement of the eyes is a rare symptom, and seems to indicate a lesion of the quadrigeminal region. Gowers has recorded a case (*Trans. of the Ophth. Soc.*, I, p. 117) in which this symptom was present, and in which a small tumor was found in the middle line behind the posterior quadrigeminal bodies, damaging these slightly, the velum, and the adjacent parts of the inferior vermiform process of the cerebellum. He points out that it should be remembered that disease of the nerves or their roots may chance to affect only the fibres for the superior recti. This was apparently the case in a patient of Thomsen's (*Berl. Gesell. f. Psychiatrie*, June, 1886) with an interpeduncular syphiloma. One superior rectus was more affected than the other, a character, Gowers thinks, which is probably of diagnostic importance. In a case of tubercle of the corpora quadrigemina, Henoch (*Berl. klin. Woch.*, 1864, No. 13) observed loss of power of the upward motion of the eyeballs as the first focal symptom to appear; and Steffen published (*Berl. klin. Woch.*, 1864, No. 20) a similar case. Paralysis both of the upward and of the downward motion of the eyes, sometimes with ptosis, while the lateral motions are unimpaired, has also been observed,

and Gowers thinks it is probably also due to a lesion in the quadrigeminal region. The symptom has been caused, too, by disease in the corpus striatum and optic thalamus (Wernicke, *Berl. klin. Woch.*, 1876, p. 394, and 1878, p. 154; quoted after Gowers). Lang and W. A. Fitzgerald reported a case to the Ophthalmological Society (*Trans. of the Ophth. Soc. U. K.*, ii, p. 230) in which this symptom and hemianopsia were the two focal signs. The case recovered, leaving only homonymous insular scotomata. The most recent case on record is Sharkey's (*Brain*, Summer No., 1894, p. 238). It is tolerably certain that the loss of power of the upward or of the downward motion of the two eyeballs, or of both of these motions, in these cases of tumor of the quadrigeminal bodies is a distant symptom, yet one of diagnostic value, and does not indicate the presence in these bodies of a centre for those motions analogous to the centre for conjugate lateral motions in the nucleus of the sixth nerve. In Bruns's case of tumor of the corpora quadrigemina (*Archiv f. Psychiatrie u. Nervenkrankheiten*, 26, p. 299) the upward and downward motions were intact, while in his case of tumor of the cerebellum there was complete paralysis of the downward motion of each eyeball. In some way which we do not yet understand—it may be by pressure or otherwise—tumors of the quadrigeminal bodies sometimes, and also, though more rarely, tumors of the cerebellum, are competent so to act on the nuclei in the aqueduct of Sylvius which govern these motions as to paralyze them without interfering with the powers of neighboring nuclei. A symptom which is the very opposite of conjugate deviation or paralysis may be best referred to here. It consists in deviation of one eye downward and outward while its fellow is turned upward and inward. This remarkable and as yet wholly inexplicable symptom has been seen only with lesions of the middle cerebellar peduncle, and the lesion may or may not implicate the neighboring cerebellar substance.''

Corps. (F.) Body. Substance.

Corps cristallin. (F.) Crystalline lens.

Corps de la monture. (F.) Lens tube.

Corps étranger. (F.) Foreign body.

Corps hyaloïde. (F.) The vitreous body.

Corps lumineux. (F.) Luminous body.

Corps phacoïde. (F.) Crystalline lens.

Corpus adiposum orbitæ. (L.) The pad of fat placed behind the eyeball in the orbital cavity.

Corpus bigeminum. A name given to the optic lobe of Fishes, Amphibians, Reptiles and Birds—the chief cerebral connection of the

optic nerve. The great size and complicated structure of this organ indicates that it is sufficient for the reflection and elaboration of the visual impulses. See **Comparative ophthalmology**.

Corpus callosum, Ocular relations of the. The corpus callosum is the great commissure of the brain; a mass of white substance which connects the cerebral hemispheres. It lies at the bottom of the longitudinal fissure, and has a length of about 4 inches. Its form is arched, the convexity of the curve being upward. Anteriorly it bends downward (at the genu) and backward to the base of the brain, and terminates in two diverging masses (peduncles) which run across the anterior perforated space to terminate near the Sylvian fissure. Posteriorly it ends in a rounded projection called the splenium. In structure it presents a fibrous character, its upper surface showing numerous transverse bundles of nerve-fibres. The lower surface is continuous posteriorly with the fornix, but it is separated from the latter anteriorly by the septum lucidum. It is essentially commissural in its office, its fibres entering all three of the principal cerebral lobes.—(Foster.)

Tumors of the corpus callosum either fail to produce eye symptoms, or if they give rise to choked disc, that sign is generally late of development.

Puncture of the corpus callosum (Balkenstich) has recently come into vogue in the treatment of the eye-symptoms of brain tumor. For instance, Hessberg (*Berl. klin. Woch.*, 1912, No. 50; also, *Woch. f. Ther. u. Hyg. des Auges*, January 23, 1913), reports five cases of hydrocephalus and two cases of brain tumor in which this operation was performed. From a study of the cases and the literature he draws the following conclusions: Puncture of the corpus callosum is a comparatively simple cranial operation for the relief of increased intracranial pressure, even infants bearing up well under this treatment. There usually follows a decided lowering of tension, showing itself objectively in the writer's cases by a decrease in exophthalmos with improvement in the visual field and regression of the nerve swelling; subjectively by disappearance of headache and improvement in the general condition. In several cases of hydrocephalus the improvement was permanent, and in a few a cure seems to have resulted. The operation is less dangerous than a palliative trephinement, and not followed by cerebral hernia.

Corpus ciliare. (L.) Ciliary body.

Corpus ciliare choroideæ. (L.) That portion of the choroid anterior to the ora serrata.

Corpus ciliare hyaloideæ. (L.) That portion of the vitreous between the ora serrata and the crystalline lens.

Corpus ciliare retinæ. (L.) That portion of the retina between the ora serrata and the iris.

Corpuscles, Corneal. These are connective-tissue cells contained within the lymph channels of the substantia propria of the cornea. See **Histology of the eye.**

Corpuscles, Krause's. These are special nerve endings in the conjunctiva found beneath the epithelium and discovered by Krause.

Corpuscles, Sclerotic. As in the case of the cornea, the interlacing bundles of transparent fibrous tissue contain a system of lymph spaces in which are found connective-tissue cells—the so-called *sclerotic corpuscles.*

Corpuscoli fissi della cornea. (It.) Corneal corpuscles.

Corpus crystallinum. (L.) Crystalline lens.

Corpus crystalloides. (L.) Crystalline lens.

Corpuscular theory of light. This theory, supported by Newton, for a long time held its ground against the undulatory theory. The corpuscular theory supposes that a luminous body shines in virtue of the emission of minute particles: these corpuscles are shot out in all directions, and are supposed to produce the sensation of vision when they strike the retina. This theory was for a long time felt to be unsatisfactory because whenever a new fact regarding light was discovered, it was always necessary to make some supplementary hypothesis to strengthen the theory; whereas the undulatory theory was competent to explain everything without the addition of extra hypotheses.

Corpus epitheliale. (L.) In the *Cephalopods,* the thickened anterior edge of the choroid coat of the eye, continuous with the lens. See **Comparative ophthalmology.**

Corpus hyalinum. (L.) Vitreous body.

Corpus hyaloideum. (L.) A synonym of corpus vitreum, or vitreous body.

Corpus Luys. In the subthalamic region of the brain, external to the red nucleus of the tegmentum, is a lens-shaped body called the *corpus subthalamicum,* or Luys' body. It has few cells, but presents an abundant plexus or fibres.

Corpus striatum, Ophthalmic relations of the. This is one of two important cerebral basal ganglia. They probably serve not only to modify impulses that pass through them but to originate subconscious impulses that play an important part in mentalization. Nothnagel

has given the following signs and symptoms of lesions of this body: Vaso-motor paralysis of the side of the body away from the lesion, —elevation of temperature, redness and edema of the skin; apparent ptosis on the paralyzed side, owing to contraction of the palpebral aperture, but the lid can be raised; a shrinking back of the eyeball into the orbit, so that it seems to have become smaller; contraction of the pupil of the same eye; abnormal secretion of thin mucus from the corresponding nostril, of tears from the affected eye, and of saliva from the corresponding side of the mouth.

Corpus subthalamicum. Luys' body. See **Corpus Luys.**

Corpus vitreum. (L.) Vitreous body. Vitreous humor. One of the transparent media, or so-called humors, of the eye lying between the lens, the suspensory ligament, and the retina; it acts as a basal support of the last named. It is a flattened spheroid, with a depression in front, called the lenticular fossa. It is inclosed in a vitreous membrane, called the hyaloid, which is folded into the depressions of the ciliary body. The vitreous humor is a transparent, jelly-like substance, and by some histologists its middle portion is said to be arranged in concentric layers, while its outer parts are divided into sectors, but this is probably incorrect. A canal runs through its centre from the optic nerve to the lens, which contains the remains of the hyaloid artery of fetal life. See **Histology of the eye**; as well as **Anatomy of the eye.**

Corradiation. The act of radiating together, as in the case of focused rays.

Corr, Albert Campbell. A well-known ophthalmologist of central Illinois. He was born in Honey Point Township, Feb. 10, 1840, the son of Thomas and Preshea Wood Corr. Because of the war, he was late in obtaining an education. In 1863-64 he studied at Blackburn University, from which institution he was later graduated in course with the Master's Degree in Arts. In May, 1864, he enlisted in Company F, 133d Ill. Infantry, and served four months. During this period he received the customary $13.00 per month, at the same time paying a man at home $21.00 per month to look after the crops. Three brothers and two adopted brothers were also in the service, and one of the brothers was killed.

After the war, he worked for a time on the farm, then, in Oct., 1865, he entered the Chicago Medical College, from which institution he graduated March 4, 1868. The year he entered the medical college he married Miss Lucinda Hall, an instructor, who continued teaching school nearby that she might look after the interests of the

mother and care for her until the son and husband could return. In deference, also, to Corr's wishes, his wife studied medicine, that she might be still more closely associated with him. She received her medical degree in 1874. Then, for eight and twenty years, she practised her profession with him.

A. C. Corr.

During all this period of professional work, the domestic side of life of these comrades was never in the least neglected. As was finally said by one who knew: "Their home life was a truly ideal one. The tender companionship and mutual helpfulness that like pursuits had developed between them was as unusual as it was beautiful. Seldom do two people enter as fully into each other's life as did these two and their devotion was the delight of all who came under their roof-tree, where high, noble thoughts and aims prevailed. Few men were capable of such living. A gray-turbaned son of Arabia would have called Dr. Corr 'a brother of girls,' a title purer and sweeter far than any that graced a knight of the round table.

"Deprived of children of their own, they were always reaching out to help orphans and the homeless, believing that the childless home and the homeless child should be brought together."

Albert Corr continued in general practice until obliged to relinquish it by steadily increasing asthma—the result of much exposure along country roads. He had always had some inclination for ophthalmology and otology, so, in 1886, he engaged in graduate study at New York, Baltimore and Chicago. Thereafter he devoted all his time and energies to diseases of the eye, ear, nose and throat.

He was also active in medical society work. He was one of the founders and charter members of the Macoupin County Medical Society, which was organized in 1873. For the first ten years of the existence of this society, he was nearly always the acting secretary. Then, in 1883, being elected president, he wrote for the organization a history of its first ten years of work. During these years he had not missed one single meeting, and he had also contributed far more papers than any other member. Altogether, he was secretary of this society for more than 25 years.

He was always ethical in his relations to his professional brethren, and likewise to the public and the state.

He was chosen by Gov. Altgeld (Democrat) as one of the delegates to the Pan-American Medical Congress, held at Washington, D. C., in 1893. He was also selected by Gov. Tanner (Republican) as a member of the Illinois State Board of Health. He became the President of the Board, and gave much of his time and energies unstintedly to the work.

In 1896 he was elected President of the Illinois State Medical Society.

He was for a time ophthalmic surgeon to Henrietta Hospital, East St. Louis, and to the Air Line Railroad. He also maintained a small private hospital at his home in Carlinville.

Dr. Corr was an excellent operator, and a slow but painstaking and accurate diagnostician. He made a drawing of almost every fundus that he looked at—a fact mentioned here to demonstrate how well the typical, well-trained careful "country" oculist, though deprived of nearly all association with his fellow ophthalmologists, may do his work. Corr invented a lachrymal duct irrigator, which met with considerable acceptance. He also invented an excellent schematic eye. This is said by many to be the best contrivance of its kind. It is of natural size, exhibits the natural motions of the ball, and

displays an easy means of measuring the emmetropic, the astigmatic, the hypermetropic, and the myopic globes.

The doctor's health, which had been but delicate before he entered upon the practice of ophthalmology and otology, continued steadily to fail. In consequence of this, in Feb., 1902, he and his wife set out for southern California, thinking that the climate of that region might prove to be of benefit to him. For a very brief while, he did improve; then came a sudden relapse, and, feeling the shadow of death upon him, he hastened home, took to his bed and was never again able to leave it. He died April 2, 1903, aged 62.

Though not of unusual size, Dr. Corr was a man of impressive presence. He was 5 feet 8 inches in height, and weighed about 140 pounds. His hair was brown, his complexion light, his eyes were large, and of a soft, expressive blue. He was very merry, witty and entertaining, always avoiding, however, even the slightest possible offense. When he entered a room, a cheerful spirit seemed to come over all the company. He loved children dearly, and was loved by them as dearly in return. He was carefully respectful to the aged. A man of extremely sensitive nature, he sometimes suffered terribly when operating, though so great was his self-control that none of those who stood around him could have deduced by his quiet, earnest ways anything else than ordinary scientific interest. He was a great sufferer, also, from asthma, and, too, from repeated migraines, a tendency inherited from his mother. These latter and most cruel afflictions sometimes completely prostrated him. Yet he worked on and on, and his work was to him a constant stimulus and solace.

Among Dr. Corr's more important writings are:

1. State Medicine and Sanitation (1890).
2. Vision; Its Physical Defects and Mode of Correction. For Teachers (1890).
3. First Clinic Ever Given in East St. Louis, Ill. A Case of Error of Refraction Complicated with Esophoria, Producing Persistent Asthenopia (July, 1890).
4. Little Things in Ophthalmology. Three Papers (1891).
5. Anomalies in Ophthalmic Practice (1895).
6. Medical Aspect of Crime—A Plea for Moral Training (1896).
7. Choroiditis and Choroido-Retinitis in Young Persons (1898).
8. Specialisms in Medicine; the Relations of the Specialist and General Practitioner (1899).
9. Advance in Ophthalmology and Otology (1899).

10. Influence of Nasal Diseases Perpetuating Diseases of the Eye; Illustrated (1899).

11. Cyclitis (1899).

12. A Resumé of Ophthalmology (1900).

13. Relations of Ophthalmology and Otology to General Medicine (July, 1901).

14. Minor Diseases of Nose and Throat that Hinder Voice Culture (1901).

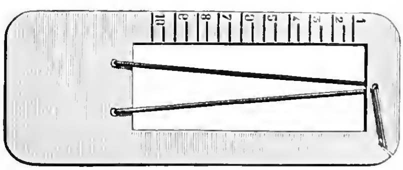
15. Minute and Foreign Bodies Superficially Wounding the Eye (1901).

16. Anisometropia: A Case Showing the Necessity of Some Objective Method of Determining Refraction; Illustrated (1902).—(T. H. S.)

Correction. CORRECTING LENS. CORRECTING PRISM. In optics the elimination of aberration from a lens. This term is also used to indicate the prescription of lenses that neutralize a patient's refractive error, or prisms that restore a lost or defective oculomuscular balance.

Correlation theory of color-perception. See **Color sense and color blindness.**

Correscope, Surrel's. An instrument for examining and determining the size of the pupil. A pupilometer.



Correscope of Surrel.

Corresponding points of the retinæ. IDENTICAL POINTS OF THE RETINÆ. The theory of identical points assumes a correspondence of each point of one retina to a similarly situated point on the retina of the other eye. When the eyes are directed toward a far-distant object, the visual axes being then parallel, a correspondence actually exists; but when the visual axes converge the points do not converge. Furthermore, a part of each retina has no corresponding points in the other. This is due to the fact that the actual centre of the retina is not at the fovea centralis, but lies nearer the nasal side. So long as the images of a point are within the horopteric circle they

fall on corresponding parts of the retinæ. Images of a point outside this circle do not fall on corresponding points.

Since the doctrine of identical points is true for only some visual acts, an attempt must be made to explain binocular single vision without the horopter. Such objects as are situated outside the horopter are seen double, but it is possible to obtain only a single cerebral impression of them. Thus, the expert ophthalmologist keeps both eyes open while examining the fundus. The image seen by one eye in this case is ignored. Under some circumstances a new mental picture of two combined dissimilar retinal impressions is made. Thus, ideas of solidity and depth are obtained in binocular vision by the mental combination of dissimilar retinal impressions, as in using the stereoscope. This is an instrument by means of which two somewhat similar pictures, drawn in perspective, are superimposed so that they appear single. One reason why non-identical points yield good vision is that vision becomes less distinct as we pass from the centre of the retina, and the observer learns to neglect the blurred peripheric images while giving attention to those formed on the fovea.—(J. M. B.)

Correspondirende Bilder. (G.) Corresponding images (of the retina).

Correspondirende Ebenen. (G.) Corresponding (retinal) planes.

Correspondirende Linien. (G.) Corresponding (retinal) lines.

Correspondirende Meridiane. (G.) Corresponding (retinal) meridians.

Correspondirende Punkte. (G.) Corresponding (retinal) points.

Correspondirender Empfindungskreis. (G.) Corresponding sensational areas—usually spoken of the two retinæ.

Correspondirende Visirlinien. (G.) Corresponding visual lines.

Corr, Lucinda Hall. A well-known ophthalmologist of central Illinois, wife of Dr. Albert Campbell Corr, the subject of the immediately preceding sketch. She passed from life when the present volume was almost ready for the press (Sept. 3, 1914) but, fortunately, the salient facts of her career have been presented in the sketch of her husband. We may add that she was a daughter of Oliver W. and Deborah Redman Hall, pioneers of Macoupin County. Her professional degree she received from the Northwestern University Woman's Medical School, Chicago, in 1874, and was the first alumna of that institution. She was a member of the Macoupin County Medical Society for more than 40 years continuously. She was a woman of great personal beauty and charm, and of fine conversational ability, as well as a skilful ophthalmologist, and her influence in the

community in which she lived was very great, and, in every instance, on the side of right. Her devotion to her sickly husband, whose

Lucinda Hall Corr.

able assistant in his practice she was until his death, was no less remarkable, and a matter of common note.—(T. H. S.)

Corrosion of the eyes. This expression is used by some writers to indicate the destructive action of strong chemicals on the eye—especially of concentrated acids and alkalis. For an extended account of this form of injury see **Injuries of the eye.**

Corrosive mercuric chloride. See **Mercury bichloride.**

Corrosive sublimate. See **Mercury bichloride.**

Corrugator Coiterii. (L.) COITER'S CORRUGATOR. The corrugator supercilii muscle.

Corrugator supercilii. This appendage of the ocular apparatus is a small, narrow, pyramidal muscle, placed at the inner extremity of the eyebrow, beneath the occipito-frontalis and orbicularis palpebrarum muscles. It arises from the inner extremity of the superciliary ridge and passes upward and outward to be inserted into the lower surface of the orbicularis opposite the middle of the orbital arch. Its action is to corrugate or wrinkle the brow.

Cortextritur. (G.) Förster's method of maturation of cataract, described in Vol. I, page 636 of this *Encyclopedia.*

Cortex, Visual area of the cerebral. CORTICAL CENTRES OF VISION. Although this subject will be discussed under the caption **Neurology of the eye,** as well as under **Intracranial organs of vision,** it may be said here that the cortical optic fibres lie at the back of the hemisphere. They are distributed to the optic lobe, including the cuneus and the margins of the calcarine fissure.

Cortical blindness. See Vol. II, page 1129 of this *Encyclopedia.*

Cortical cataract. An opacity of the lens mainly or entirely centred in the cortex—the nucleus, the capsule, and sometimes the subcapsular layer of the lens remaining transparent until the end. The change often begins in the superficial parts at the equator of the lens, in the form of sharply-defined lines or streaks, or triangular patches. See, also, **Cataract, Cortical.**

Cortical center. See **Cortex, Visual area of the cerebral.**

Cortical reflex, Haab's. According to this test the patient sits in a darkened room and thinks intently about a bright light; the pupil then contracts.

Cortical retina, The. Oliver (*Am. Jour. of Med. Sc.,* Jan. and Apr., 1885) believed that to a certain extent the retina—apart from the optic fibres—is represented in the cerebral cortex. In that sense one may speak of the cortical retina.

Cortico-optique. (F.) Pertaining to the cortex cerebri and optic thalami.

Coruscation. A glittering or flashing of light; also the subjective sensation of light-flashes. Phosphenes.

Corybantism. (n.) An old term for wild delirium with fantastic visions, in which there is no sleep, or only sleep with the eyes open.

Coryza, Ocular symptoms of. A nasal discharge, more or less marked, is a not uncommon accompaniment of certain diseases of the eye, notably vernal conjunctivitis, Koch-Weeks conjunctivitis and other acute diseases of the conjunctiva, cornea, iris, etc. A coryza, as is well known, may also set up eye symptoms or be associated with them. This subject is also dealt with under **Cavities, neighboring, Ocular relations of.**

Cosmetic ophthalmology. The relief of malformations and other disfigurements affecting the eye—the external eye in particular—falls under this heading. The various operations and devices required to cover up or cure disfigurements fall under such separate headings as **Ecblepharos**; **Squint**; **Cicatricial orbit**; **Tattooing**; **Blepharoplasty** and similar captions.

Cosmetics, Amblyopia from. Accounts of ocular injury from the use of various cosmetics, such as hair dyes, face powders, "bleaches," facial creams, salves, rouge, *et hoc genus omne* of the "beauty shop," are mostly concerned with compounds containing salts of lead; these reports occur in ophthalmic literature as early as the 17th century. A fairly complete review of them may be found in Lewin and Guillery's *Die Wirkungen von Giften auf das Auge*, Vol. I, pp. 534 and 616. The symptoms, apart from the local irritation (chiefly hyperemia and inflammation of the conjunctivæ) are those of lead-poisoning in general—saturnine colic, anemia, headache, constipation, wrist-drop, oculo-muscular pareses, optic atrophy, etc. A full account of this matter will be found under **Toxic amblyopia.** See, also, **Dyes, Hair**; as well as **Conjunctivitis, Face powder** (Vol. IV, p. 3101 of this *Encyclopedia*).

Cosmoline. Paraffinum molle. Albolene. Saxoline. White vaseline. Soft paraffin. Adeps petrolei. Paraffin jelly. Petrolatum molle, U. S. Purified vaseline. Vaseline. The foregoing are some of the official and trade names of that semi-solid, greasy, neutral, odorless and almost tasteless mixture of soft paraffins, both yellow and white, so well known to the profession and the public. It is said that the action of the vegetable alkaloids, such as cocaine and morphine, is materially diminished when any form of it is used as an excipient, and that cocaine hydrochloride cannot be used in this way. The name cosmoline is applied to a white or purified proprietary petrolatum. Both the impure and purified product are useful as an ophthalmic salve, applied to the lid edges and instilled warm or otherwise introduced into the conjunctival sac. In both situations it acts not only as an emollient but as an aseptic coating, in several instances inhibitory of the growth of morbific germs.

Cosmosphere. A terrestrial globe mounted within a hollow glass celestial globe on which the constellations are depicted.

Cotarnin. Stypticin. This is an oxidation product of narcotin (an alkaloid obtained from opium and used instead of quinin in intermittent fever), and as cotarnin hydrochloride appears in the market as yellow crystals easily soluble in water. It is styptic, hemostatic, analgesic and anesthetic. The dose is from 1 to 1½ grains, generally given in pearls or capsules; it may be used hypodermically. It is also used externally, pure or in strong solution, on gauze or cotton as a local styptic.

In the Bird's eye this agent is said to produce dilatation of the pupil for several hours. According to Meyer this results from a paresis of the oculo-motor endings in the iris.

Côté. (F.) Side or flank.

Couche. (F.) Layer; as, for instance, *la couche granulée,* the external granular layer.

Couché. (F.) Lying down; recumbent.

Couching of cataract. Couching of the lens. Reclination. Declination or depression of cataract. A full description of this operation is given in Vol. II, p. 1473, of this *Encyclopedia.* To the account there furnished may be added the description by Ekambram (*Indian Med. Gaz.,* 14, No. 3), who describes the Indian coucher's operation as an eye-witness trained in modern cataract extraction. Two instruments were used: one a sort of steel vaccinating lancet without a handle, round which was wrapped dirty cotton to within 2 mm. of the point; the other a copper probe which was three-sided for a distance of 12 mm. from one end, and which was wound with dirty cotton at the place where it became three-sided. This cotton served the purpose of the stop in a Bowman's needle. The operator, who had refused to sterilize his hands and instruments, faced the patient, and told her to look toward the side away from the cataract. With his thumb nail he marked out over the sclerotic, at a distance of about 12 mm. from the cornea and 2 mm. below the horizontal meridian of the globe, the point at which his instruments were to enter. It will be seen that the dangerous zone was avoided. Telling the patient that he was going to apply some medicine, a portion of some paste which he had prepared was taken up on the tip of the cotton wound lancet and the lancet plunged into the eye. Having stated that the medicine application was over, he next inserted the copper probe into the puncture about as far as the stop, and, with a circular motion of the tip on the puncture as a fulcrum, tore the suspensory ligament, after which with a gentle downward stroke the lens was depressed. The operator removed the probe, covered the patient's sound eye, and demonstrated to the onlookers her ability to recognize various surrounding objects. The eye was dressed with an irritant paste, and with a dirty wet cloth. The group of itinerant operators left the village on the evening of the day following the operation. By the next morning the eye had developed a severe septic iridocyclitis. The operators, who are known as Vydians, come from a village of about thirty families, who are also agriculturists. The couching of the lens has been practiced by

them and their forefathers from time immemorial. They also practice general surgery. They generally touch only mature cataracts, and avoid cases in which the pupils do not react well to light. The surgical character of the interference is carefully concealed from the patients. Elliot, who comments on Ekamabram's paper, considers that probably over 40 per cent. of the eyes operated on by the Vydians are lost by sepsis. He is disposed to think that some of the couchers attack the cataract from in front instead of behind. (*Ophthalmic Year-Book,* 1911, p. 186.)

The number of cases of couching done in India by the Vydians, or native practitioners, of which Elliot has obtained records, now amounts to 550. He declares that the methods of the native coucher are crude, filthy and dangerous, and his results appalling. The economic aspect of his work is the more serious, because in India cataract attacks its subjects in their mature age, dooming them to many years of blindness. In only 21.64 per cent. of the 550 cases was vision of more than 1/10 obtained, and only another 16.69 per cent. had from 1/10 to ability to count fingers close to the face. The majority of the better results were found in patients who had been operated upon within two or three years. Of the total number of cases 35.76 per cent. were lost from iritis and iridocyclitis, 11.05 per cent. from glaucoma, and 8.94 per cent. from imperfect dislocation of the lens.

Meyerhof saw in Cairo, Egypt, four patients who had been operated upon by traveling couchers. In two of them the corrected vision was 5/10 and 5/7.5, respectively. In a third the eye was removed a year after the couching, because of iridocyclitis. In the last case the cataract had almost returned to its normal position since the operation. Levinsohn, dealing with some recent suggestions for more frequent use of couching instead of extraction by modern surgeons, believes the only indications for such a course to be pronounced hemophilia and a combination of old age with mental disease.

Couleurs de contraste. (F.) Contrast colors.

Coulomb. The unit of measurement of electric quantity; that is to say, the quantity of electricity passing during one second through a conductor with a resistance of one ohm, with one volt of electromotive force. The *micro-coulomb* is the millionth part of this amount.

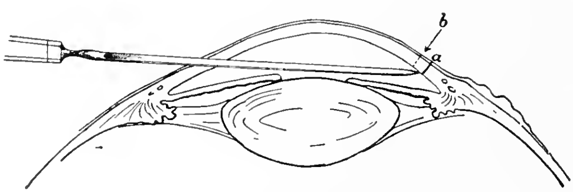
Coulomb's eye-cup. Both Coulomb (*L'Opht. Prov.,* 9, p. 129) and John Green, Jr. (*Am. Jour. Ophth.,* 29, p. 264) have simultaneously

improved the ordinary glass eye-cup by adapting to it a rubber cylinder, with a soft rubber roll secured upon the rim of the cup, as shown in the figure.

Eye-cup of Coulomb with Adaptable Rubber Rim.

Counter-irritants. See **Rubefacients.**

Counter-puncture. This is the second puncture of the cornea or sclerocorneal junction made (usually) in cataract extraction, and, as a rule, done as nearly as possible at a point exactly opposite the puncture.



Counter-puncture in Senile Cataract Extraction.
The counter-puncture should be made at *a*, although in obedience to the laws of refraction, the point of the knife appears at *b*.

Coup de feu. (F.) A gunshot wound.

Coup de soleil. Sunstroke.

Courbure de champ. (F.) Curvature of the field.

Courbure de la surface focale. (F.) Curvature of the field.

Couronne ciliare. (F.) The entire circle of the ciliary processes.

Court systems. These have in various countries important relations to ophthalmic expert testimony and similar matters. See **Legal relations of ophthalmology,** near the beginning of the section.

Coussinet oculaire. (F.) A mass of fat behind the eye in the Solipeds.

Couteau à bouton conique. (F.) Olive-pointed knife.

Couteau à cataracte. (F.) Cataract knife.

Couteau à deux tranchants. (F.) A double-edged knife.

Couteau boutonné à tige flexible. (F.) Blunt pointed knife with a flexible shaft.

Couteau coudé. (F.) An angular knife.

Couteau en as de pique. (F.) Heart-shaped knife or keratome.

Couteau interosseux. (F.) Double-edged knife.

Couteau mousse. (F.) A small, blunt-pointed knife for undermining the ocular conjunctiva.

Couvercle d'objectif. (F.) Cap of a microscope lens.

Cover-glass. In microscopy, the thin lamina of glass covering the object mounted on the slide. It should not exceed $\frac{1}{200}$ inch in thickness. It must be remembered that because of its effect on the transmission of light, the thickness of the cover-glass must be considered in correcting the objective.

Cover-glass gauge. Fine calipers for measuring the thickness of the cover-glasses used in microscopic work.

Cover-slip. A thin piece of glass used to cover microscopical preparations. A cover-glass.

Cover test. This is a rough but useful test for heterophoria and heterotropia. One eye is covered by the hand of the examiner while the other fixes a pencil point held in front of the face at a distance of forty centimetres. After a few moments the hand is rapidly transferred to the other eye, when, if heterophoria exists, the uncovered eye will be seen to make a movement in order to fix the pencil-point. If the eye moves outward, it must have been deviated inward while under cover, indicating insufficiency of the external rectus, or esophoria. If it moves inward, it must have been deviated outward while under cover, indicating exophoria. If it moves either upward or downward, it indicates hyperphoria. If no movement takes place, the visual axis must have maintained the same direction as that of the other eye, indicating orthophoria.—(J. M. B.)

Covey, John Elsworth. One of the best known ophthalmologists of central Illinois. He was born in McLean Co., Ill., Oct. 7, 1861, the son of Cornelius and Dicey (Johnson) Covey. He came of old American stock, his granduncle, in fact, having been the messenger that carried the news of Arnold's treachery from West Point to

Hartford, where Washington then was. The subject of this sketch was educated in the common schools and at Wesleyan College, Bloomington, Ill., and at Rush Medical College, Chicago, at which institution he received his degree in 1887. In the same year he settled in Lexington, Ill., forming a partnership with a Dr. Graham. Two or three years later he purchased Dr. Graham's remaining interest.

John Elsworth Covey.

He continued in general practice at Lexington till Jan. 1, 1903—nearly sixteen years—when he decided to become an ophthalmologist. For nearly two years, then, he studied in New York and London. Later, he studied for some time with Casey A. Wood, in Chicago.

Near the close of 1904, he located at Bloomington, Ill., where he met with immediate success, and continued to practice ophthalmology until his death.

In his general practice he is said to have accumulated a small fortune.

He married, May 29, 1890, Miss Emma Lois Scrogin, of Lexington, Ill., a daughter of one of McLean County's pioneers. Of the union were born two children, Catherine and John Elsworth, Jr.

He was a stout man, five feet ten inches high, of a florid complexion and with dark-brown hair and sharp black eyes.

He was quick and active in his manner, energetic, full of fun, rather hasty tempered but always ready for reconciliation. He was conscientious and upright in his work and life.

A member of the Baptist church, he became a deacon in that institution, and the superintendent of the Sunday school. He was a Royal Arch Mason, a Knight of Pythias and a Modern Woodman. He was a tireless worker in all religious and moral enterprises. Politically, he was a Republican.

He died Dec. 13, 1907, at his home in Bloomington, of carcinoma of the stomach.—T. H. S.)

Co-vibrate. To accompany or respond to simultaneous vibrations.

Coward, William. Born at Winchester, England, in 1656 (1657?), he studied at Oxford University and there received his medical degree in 1687. He practised for a time in Northampton, then removed to London, where he published a number of metaphysical and theological works, which were publicly burned as heretical. After this he practised for a time in Ipswich.

His only ophthalmological work is entitled "*Ophthalmiatria, qua Accurata et Integra Oculorum Male Affectorum Instituitur Medela, Nova Methoda Aphoristice Concinnata Authore Gul.* Coward, Coll. Med. Lond. M.D., London, 1706." It is a poorly written work, scanty, and limited wholly to diseases of the cornea and the lachrymal apparatus, with a few remarks on cataract and amaurosis.

The man seems to have been conceited, abusive, evil-minded, and, in addition, an outrageous quack.—(T. H. S.)

Cowell's operation. Paracentesis of the vitreous chamber, employed for the relief of glaucoma.

Cow's milk. See **Milk.**

Cow, The. Milk, butter, and cheese, as well as other derivatives of cattle, were favorite remedies among the ophthalmologists of antiquity, and enjoyed an especial reputation among the laity, even as they do today. Milk was much employed in ophthalmic poultices (*cf.* the bread-and-milk poultices of the present time); butter was also used in poultices, and, further, as a menstruum in salves: while white, fresh, salted cheese, together with the leaves of certain plants, was especially useful in rheuma. Ox-gall, mixed with water and white of egg, was a favorite instillation, and the same substance,

mixed with fennel juice and oil, was especially esteemed for hypochyma (the modern "cataract") and amaurosis. Beef suet, then as now, was a favorite popular remedy, and the pith of the right fore-foot of an ox, rubbed up with charred sesame, was employed as an ocular cosmetic.—T. H. S.)

Coywell flint. This is a special flint glass put on the market in 1913 from which strong lenses of all kinds may be made extremely thin, a +8 curve giving a +12 effect on regular tools. Said to be desirable for cataract lenses.

Crab. According to Pliny (*Nat. Hist.* xxxii, 24, 18) the eyes of crabs were good for lippitudo, or purulent blepharoconjunctivitis. They were worn about the neck.—(T. H. S.)

Crab's eyes. A vulgar name for the fruit of *abrus precatorius.* See, also, **Jequirity.**

Crabs, Eyes of. In some instances one finds in these animals either the (frontal, cyclopean) Nauplius eye, placed above in the middle line of the head in the shape of one single or a group of eye spots (*Punctaugen*); or as a pair of relatively large compound eyes on the side of the head, mounted on movable (occasionally fixed) eyestalks. In some Crabs both lateral and single frontal eyes are present; in others, only the central ocelli; still others are provided with lateral eyes only. See, also, **Comparative ophthalmology.**

Cramp, Accommodation. A spasm of the ciliary muscle of the eye.

Cramp, Convergence. See **Convergence, Cramp of.**

Cramp of ocular muscles. This is a relatively rare phenomenon. Many abnormal positions of the eyes, as in the various forms of squint, have been wrongly attributed to cramp or spasm of one or more ocular muscles. To be acknowledged as such, oculomuscular cramp must display the same characteristics as spasm of other striated muscles. These are excess of movement in the direction of the spastic muscle, and inability to change the position of the eyeball, the result of such a cramp, as long as the latter endures. The spasmodic affections are usually accompanied by reddening of the conjunctiva, a flow of tears, and an unpleasant or even painful pulling sensation. Moreover, spasm of the ocular muscles is not an irregular phenomenon, as was formerly believed, but a regular and definite symptom. According to Kunn, cramp of both the external and internal muscles has been observed in conjunction with athetosis, tetanus, chorea, Thomsen's disease, eclampsia, epilepsy and hysteria.

Cramp of retinal vessels. VESSEL-CRAMP. SPASTIC ISCHEMIA. Beard (*Diagnosis,* p. 274) gives the following excellent account of this condition: "Certain local vasomotor phenomena seem to be respon-

sible for many instances of ischemia of the retinal vessels; some being due to physiologic and others to pathologic reflexes. A number of cases of sudden complete transient blindness have been observed in perfectly healthy, normal individuals, mostly young, in some of which the ophthalmoscope has demonstrated not only the ischemic condition of the vessels, but has revealed the spasmodic nature of it. Most of the cases of blindness accredited to vessel-cramp have been in connection with affections that could act as exciting causes. Among these are Jacksonian epilepsy (deWecker), intestinal parasites, Raynaud's 'local asphyxia of the extremities', intermittent fever (Schnabel), whooping-cough (Knapp), and migraine (Galezowski and Berger). Wagenmann and others have reported transient recurring blindness in arterio-sclerotic subjects. It is considered by some authorities as one of the prodromic symptoms of endarteritis. One of the more recent of these reports is that of Zentmayer, reported to the American Medical Association, at Boston, in 1906. Zentmayer had the exceptional opportunity of making repeated examinations of the fundus phenomena in his case. He says concerning his findings: 'Ophthalmoscopic examination showed a moderate contraction and distinct flattening of the arteries and veins at the onset of an attack of blindness. When the blindness is complete, the arteries become ribbon-like and lose their reflex, and the veins, especially the superior branch, become very narrow. After a brief period there is a gradual refilling of the arteries and veins, the latter becoming greatly distended, particularly the inferior branch. During the latest attack that was observed, the last of a long series occurring at half-hour intervals, there appeared to be some retinal haze about the disc. There were never any macular changes. The pupil dilated synchronously with the loss of vision, and for a while after the attack exhibited hippus.' "

Wagenmann's observations, as quoted by Zentmayer are: "A man, aged sixty-nine years, had for two months noticed frequent, and of late almost daily, attacks of blindness in the right eye, lasting from a few minutes to a few hours. He had had epileptiform attacks in childhood, but was now healthy, except for arterio-sclerosis. The changes observed were, that in a short time perception of light was gone, and with it direct and consensual pupil reaction. Externally no change. Ophthalmoscopically, disc pale, arteries appeared as shiny streaks in which no blood-columns could be seen, even with the direct method. Veins thread-like. No pulsation on pressure. Soon the retina became cloudy and the fovea (foveola) stood out as a round red spot. About ten minutes after the beginning of the

attack a fine, red line was seen by the indirect image to appear in the arteries, and immediately afterward the veins became large. Thereupon the patient had perception of light, and the pupil reacted a little. In a few minutes the circulation, and with it the vision, was completely restored.''

In two cases, one by Benson and the other by Sachs, also quoted by Zentmayer, the vessel-cramp was actually visible with the ophthalmoscope. For more than four years a man, aged thirty-two, in good health, had had numerous attacks of transient blindness, sometimes complete, at other times involving only a section of the field. During an attack of complete blindness the ophthalmoscopic examination revealed the inferior temporary artery entirely bloodless for a distance of four discs diameter from its point of emergence. The bloodless section was seen to shift toward the periphery until it reached the next large bifurcation, when it suddenly disappeared, leaving the blood-vessels normal. The same phenomena were noticed during attacks of partial blindness.

Sachs' case resembled that of Benson: In the affected eye a circular constriction would start from the papillary end of the inferior artery and travel to the point of first bifurcation, taking from three to five minutes to make the journey, a distance of one-half the disc's diameter. The fundus typified that of embolism. When again seen, three days later, only the picture of embolism was present. The patient had arterio-sclerosis.

Spastic ischemia is, as a rule, monolateral. For this reason one might be led to suspect embolism or thrombosis. The ophthalmoscope should clear the diagnosis.

It is remarkable how long a time the eye may remain blind in these recurrent paroxysms, yet completely regain its integrity. The period has been reported as lasting from a few minutes to a few hours—in one case sixteen hours—without ultimate impairment. In bilateral ischemia of a girl five and one-half years old, in which blindness had lasted a number of days, Graefe restored the sight by iridectomies, and Rothmund was enabled to perform a similar fortunate office for two girls, one thirteen, the other eighteen, who had been totally blind in both eyes for several days. The reason why the retina suffers so little permanent injury in these cases is that during the spasm of the vessel the arrest of the circulation is not complete, but that there remains a tiny stream of blood, too feeble to admit of visual function, yet sufficient to safeguard the anatomic integrity of the retina. This explanation does not satisfy those who have noted that very pronounced ischemia of the retina was not incom-

patible with good vision, and who believe that to cause complete blindness the interruption must also be complete. Ischemia, purely spasmodic, is generally of shorter duration than that whose determining cause is obstruction of the lumen. Wagenmann aptly states that in thickening of the intima, which is common in certain individuals past the age of forty, spasmodic contraction of the retinal arteries that would otherwise pass unnoticed would produce ischemia. Hence the graver prognosis of the affection is precisely as regards this class of subjects. For them the vision once lost from sudden transient spasm would be less likely to be restored with the passing of the spasm. Leber is one of those who believes that vessel-cramp may be sufficiently prolonged to produce permanent blindness. The prognosis is, nevertheless, favorable, for most of the cases are, from the start, transitory and many of the others are amenable to surgical treatment. Knapp and Berger cured their patients by paracentesis, and Wagenmann relieved his of intermittent blindness by iridectomy.

Crampton's muscle. The principal factor in the accommodation of Birds' (and of some Reptiles') Eyes. See **Comparative ophthalmology.**

Crampton's operation. In this procedure (for the relief of entropion) the operator (*Essay on Entropion*, 1806) divided the lid by means of two perpendicular incisions, one at each canthus. These extended from "three lines above the orbital margin of the cartilage to the edge of the lid, and not even sparing the canaliculus." The flap thus formed, comprising the whole of the upper lid, was everted against the brow and held in position by a kind of speculum of silver and a bandage.

Crane's bill, The round leaved. Verbena officinalis. In ancient Greco-Roman times, verbena, mixed with honey and the oil of roses, was often employed as a remedy for epiphora.—(T. H. S.)

Cranial deformities, Eye symptoms of. TOWER SKULL. OXYCEPHALY. There can be no doubt but that congenital malformations of the skull are occasionally associated with and are, either directly or indirectly, the causes of optic lesions. This subject will be further considered under **Tower skull** and **Oxycephaly**. Here a few references to the subject will be made. For example, H. Larsen (*Klin. Monatsbl. für Augenheilk.*, 1913, Aug., p. 145) describes nineteen cases, 16 male and 3 female. He also refers to the statistical material collected by Patry in 1905, which included 58 men and 10 women. Thirteen of Larsen's patients showed a typical boss on the top of the head; 14 had more or less exophthalmus. There was diver-

gent strabismus in 17, convergent in 2 and nystagmus in 15. With the exception of one eye of one patient, which had 6/6 vision, all the patients had very low visual acuity, the best vision being fingers at two to three metres. But most of them were inmates of an institution for the blind. In three of six cases which came to autopsy, there were defects in the cranial wall. The view that optic atrophy in these cases is a direct consequence of increased intracranial pressure, is supported by the fact that in two cases which came to section there was blindness without any narrowing of the foramen opticum. As regards the prognosis of cases of tower skull, it is noted that two cases had died of purulent meningitis and were found to have hernia of the brain into the nasal cavity. Only one of the 19 patients was mentally defective. (*Ophthal. Literature,* 1913, p. 157.)

Cases of tower skull with visual disturbance have been reported by Paltracca (*Archivio di Ottal.,* 16, p. 401, 1909) and Merle (*Ann. d'Ocul.,* 141, p. 125, 1909), who ascribe the condition to premature union of the sutures. Hirschberg and Grumach (*Berl. klin. Woch.,* Feb. 1, 1909) have seen a series of 7 cases and call attention to the appearances brought out by the x-ray. In one case the sella turcica was double its normal size, which would account for the condition of the optic nerves.

Carpenter has also presented a skull from a patient thus affected. The orbits were very shallow and elongated vertically. The cranial cavity was compressed antero-posteriorly, the cerebrum being curled in the shape of a loop, with the frontal and occipital lobes only 1½ inches apart. The anterior lateral fontanelles were very large and covered by a membrane. Romme (*La Presse Med.,* No. 17, 1909) believes that the optic nerve changes in these cases may be due to meningitis occurring soon after birth, to ossification of the fontanelles; and to compression of the nerves or to exostoses, with increased intracranial pressure. Anton (*Muenchen. Med. Woch.,* No. 34, 1909) resorted to trephining in a man aged 30, incising the dura and passing a probe into the ventricle. The operation gave relief from headache and vertigo, and vision in the better eye increased from ⅓ to ⅔. He regards such deformities as due to obstruction of the venous circulation.

Three cases of tower skull with blindness from optic atrophy are reported by Dorfmann (Graefe's *Arch. f. Ophth.,* 68, No. 3, 1908). From a study of these and previously reported cases, he attempts to arrive at the pathogenesis of the condition, and a rational suggestion for its therapy. He concludes, partly from the insecure basis of Roentgen ray plates, that tower skull is due to premature

union of the sutures, which causes an increase of intraocular pressure. This, with local alteration in the bones, sets up an optic neuritis with subsequent post-neuritic atrophy. Dorfmann believes that trephining will relieve the intracranial pressure, and prevent its deleterious action on the organs of vision. For the cause of premature closure of the sutures he is inclined to look to anomalies of the cerebral circulation, causing congestion which does not go on to inflammation. He cannot agree with Krauss (*Year-Book,* 1908, p. 248) that it is due to rachitis, since in most of the cases no such factor could be discovered, and premature union of the sutures is rare in that disease.

Natanson (*Klin. Monatsbl. f. Augenheilk.,* May, 1908, p. 565) from a study of 6 cases of tower skull, also reaches the conclusion that the blindness by post-neuritic atrophy is due to increased intracranial pressure, and that this could be remedied by trephining. Bednarski (*Postep. Okul.,* 10, p. 33, 1908) reports 7 cases. In all there was an actual neuritis or post-neuritic atrophy. In 2 the intelligence was impaired, and in 3 there had been rachitis. While mentioning a previous meningitis as the accepted explanation of these cases, he also inclines to the view that the optic nerve changes are due to excess of cerebro-spinal fluid, rather than to an inflammation of the brain or its membranes. Optic atrophy with tower skull has also been the subject of a paper by Meltzer (*Neurol. Centralbl.,* 27 p. 562, 1908) and Lehndorff (*Mitt. der Gesell. f. inn. Med. u. Kinderh.,* 7, p. 43, 1908). A case of blindness from optic atrophy, ascribed to hyperostosis in the optic canal, is reported by Bjelski (*Klin. Monatsbl. f. Augenheilk.,* March, 1908, p. 321).

Cranial flexure, The. In *embryology* the early stages of ocular development correspond closely with the second day of the chick. Among other particulars, they show very clearly the abrupt flexure or bend downward of the anterior end of the cerebro-spinal rudiment, which has carried all the other surrounding organs along with it. This bend is known as the *cranial flexure,* and has an important bearing on the development of the face. The cranial flexure is common to all vertebrates above *Amphioxus,* and even *Amphioxus* shows traces of the development of the cranial flexure in the embryo, according to Kupffer, although the flexure disappears before the attainment of full growth and is most marked in the higher series.

Craniencephalometer. An instrument for determining the position of the gyri of the brain from the outer surface of the head.

Crapaud. (F.) Toad.

Craquelé maculaire. (F.) The deep red or black macular spot of progressive myopia.

Crassa. (L.) An old name for the sclerotic.

Crassum et durum involucrum oculi. (L.) This is an ancient and obsolete expression, introduced by Galen, for the sclera. See, for example, Norris and Oliver's *System of Diseases of the Eye,* Vol. I, p. 126, footnote.

Craters, Choroidal. Hill Griffith (*System of Diseases of the Eye,* Vol. 3, p. 354) has described these choroidal lesions in the following terms: "We sometimes meet with a single large area of choroidal atrophy at or near the centre of an otherwise normal eye which has the following characters. The area is several times the size of the disk, nearly circular, and sharply defined by a well-marked ledge; the sclerotic within the affected area is strongly bulged backward; the choroidal vessels are destroyed, or more commonly freely exposed, with large masses of coal-black pigment between them, reminding one of the appearance of the web of a frog's foot under the microscope; and the retinal vessels are free from disease. The changes are quite stationary; one or both eyes may be affected."

Cravate. (F.) A kind of triangular bandage.

Cream, Cold. See **Cold cream.**

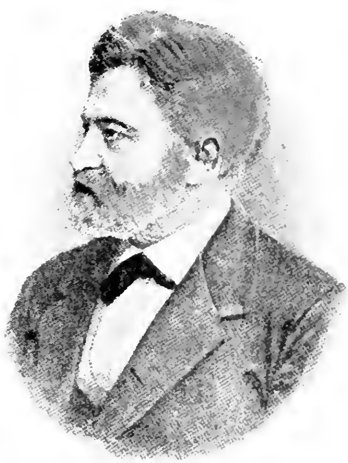
Credé, Karl Siegmund Franz. Born at Berlin, Dec. 23, 1819, he studied medicine first at Berlin, later at Heidelberg, returning, however, to Berlin for the purpose of receiving his professional degree (1842). After five long "Wanderjahre" (1843-48) he became assistant at Bush's obstetrical clinic in Berlin. In 1850 he qualified as privat-docent for obstetrics in the same institution. In 1856 he removed to Leipsic in order to accept at the university of that place the professorship-in-ordinary of obstetrics, as well as the directorship of the Leipsic Lying-in Institution and School for Midwives. In 1860 he was appointed aulic counsellor, and, ten years later, became medical adviser (Geheimer Medicinalrat). In Leipsic he remained for the remainder of his days.

Credé will be remembered, perhaps till the end of time, not only as an obstetrician, but also as an ophthalmologist. In the former field his principal invention was Credé's Method for Expressing the Placenta. In the latter, it was Credé's Method of Prophylaxis against Ophthalmia Neonatorum. It is hardly necessary to add, in a work like this, that the method in question consists simply in the instillation into the eyes of the newly-born of a weak solution of argentic nitrate. Simple as this procedure is, it has, beyond all peradventure,

saved multitudes of human beings from the horrible curse of blindness.

Among the more important works of this remarkable man (whose cosmopolitan benefactions may perhaps be regarded as symbolized by his Franco-German name) are these: "Clinical Lectures on Obstetrics" (2 vols., Berlin, 1853-54), "De Omphali Proptosi" (Dissertation, Berlin, 1842), "De Foetus in Utero Mutilatione Filis Membranisque Pathologicis Effecta" (1858), "De Optime in Partu Naturali Placentam Amovendi Ratione" (1860), "The Prevention of Ocular Inflammation in the New Born" (1884).

Credé died March 14, 1892. A memorial bust of the great ob-



Karl Siegmund Franz Credé.

stetrician and ophthalmologic innovator was erected in 1908, in the Leipsic "Universitäts-Frauen-Clinik."

Though "only an obstetrician"—as he was once called—he will always "walk in the great company"—with old Hippocrates, with the mediæval Ali ben Isa, with Daviel and Beer and Arlt and hundreds, nay, possibly, even thousands, of other ophthalmologists whose own ungestated eyes are yet to be washed by the magical solution. For Credé did more, much more, than merely to bring back sight to the blind. To a large extent, he succeeded in banishing the unspeakable monster of blindness from the very face of the earth. Would that all indifferent or ignorant physicians could be brought to recognize the immense importance of his method.—(T. H. S.)

Credé, Profilassi di. (It.) Preventive method of Credé.

Credé'sches Verfahren bei Blennorrhea neonatorum. (G.) The method of Credé in ophthalmia neonatorum.

Credé's method. The well-known prophylactic instillation of a two per cent. solution of nitrate of silver in suspected ophthalmia neonatorum, or its use in the eyes of all new-born children. See, also, **Blindness, Prevention of**; as well as **Conservation of vision.**

Credé's ointment. See **Collargol.**

Creek dots. More properly "Crick" dots (q. v.). Small shining dots, of unknown nature (often hereditary), occurring at times in the retina anterior to the retinal vessels; they were so named by Marcus Gunn, who first described them. See **Gunn's dots.**

Creeping ulcer. A term applied to serpiginous ulcer of the cornea. See **Cornea, Serpent ulcer of the.**

Creese-shaped knife. For a description of this cataract knife see Vol. III, page 1663, of this *Encyclopedia.*

Crème froide. (F.) Cold cream.

Crément. (F.) That part of the food absorbed into the system.

Creolin. This is a name given to several coal-tar products, allied to phenol and made soluble by the action of soap on cresol. The creolins are decidedly disinfectant and antiseptic. They are dark-brown, syrupy fluids with a tarry odor; soluble in ether, very little soluble in water.

As an eyewash creolin is prescribed for chronic and some acute forms of catarrhal conjunctivitis in the proportion of 1:1000 to 200. Diluted one-half with distilled water it is recommended as an antiseptic injection in dacryocystitis with muco-purulent secretion.

When corneal complications set in during an infective conjunctivitis a few drops of a one per cent. creolin solution once or twice a day has been strongly recommended in conjunction with other remedies.

A. C. H. Friedmann has found creolin of considerable value in cases of conjunctival edema from unknown causes. He prescribes it in cold applications of a half per cent. solution.

DeSchweinitz has advised a one per cent. solution of creolin in the conjunctivitis set up by atropin. He also advises a local application of the same mixture in cases of lachrymal diseases associated with a catarrhal condition of the passages.

Bitter is said to have seen a case in which this coal-tar product has produced "dullness of vision."

Crepidines palpebrarum. (L.) An obsolete term for the tarsi, the so-called tarsal cartilages.

Crescent. A synonym of Fuchs' coloboma or inferior staphyloma.

Crescent, Atrophic. See **Conus.**

Crescentic conus. See **Conus.**

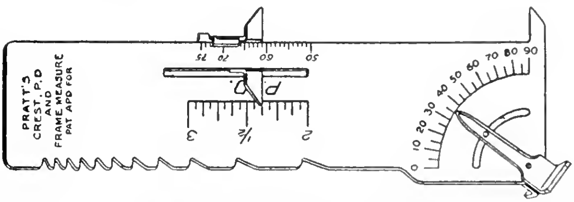
Crescent, Scleral. See **Conus.**

Crescent, Semiatrophic. See **Conus.**

Cresol iodide. See **Europhen.**

Cress. Lepidium latifolium. Watercress was applied to the eyes in ancient Greco-Roman and Alexandrian times as a poultice for ocular injuries accompanied by swelling. When the cress was taken off, the eye had to be heated for some time. Cress was also used by Philinus (*circa* 280 B. C.) as a remedy for epiphora.—(T. H. S.)

Crest measurer. There are numerous instruments used in the adjustment of glasses for determining the angle and other relations of the crest of the nose. Among these are cards and other crest measurers. This subject will be fully considered elsewhere in this *Encyclopedia.* Meantime, it may be pointed out that a simple (patented) device is



Pratt's Crest and Frame Measure.

Pratt's, which may also be used to measure the inter-pupillary distance and the angle of the bridge. To measure the crest (see the illustration) the instructions are to place the indicator base on the bridge of the nose and be sure that the measure is perpendicular to the plane of the face; the indicator hand will then register the angle of the nose crest. See, in addition, **Mechanical adjustment of eye-glasses and spectacles.**

Cretacea (cataratta). (It.) Chalky or cretaceous cataract.

Crête lacrimale antérieure. (F.) Anterior lachrymal crest.

Crête lacrymale postérieure. (F.) Posterior lachrymal crest.

Creté's prism mobile. This ingenious little instrument is the base of Risley's much improved rotary prism. Two equal prisms were moved in opposite directions by a button along the handle, at a rate proportional to the angular motion of the prisms.

Cretinism, Ocular affections in. As is well known, this affection is a deformity of the entire body, but especially of the head, the latter showing premature cranial synostosis in association with imperfect development. The disease is epidemic in the valleys of certain moun-

tainous districts, especially of the Pyrenees, the Alps, and the Himalayas. It is also found, to a less extent, in those of Syria and China. It is accompanied by mental feebleness and defects of the special senses. It is often associated with goitre. The ocular signs and symptoms are the following: The eyes are widely separated, deep in the orbit, and quite small; the interpalpebral fissure is narrow and occasionally oblique. Of 57 cretins congenital anomalies were found in 5. The pupils and fundi were, in these cases, normal. In advanced cretinism the superciliary hair is scanty and sometimes wanting.

Creux. (F.) A hollow, cavity or pit.

Cribra orbitalia. (L.) Orbital network.

Cribrate. Perforated like a sieve.

Cribriform field of vision. Visus reticulatus. When a number of irregular insular scotomata are scattered over the field of vision it is sometimes called a cribriform field or *visus reticulatus.* In this instance the smaller defects are generally found in the intermediate part of the field; near them the larger peripheral scotomata. One finds this form of field in grave cases of *choroiditis disseminata,* where the choroidal disease has invaded the layer of rods and cones and caused them to atrophy.

Cribriform ligament. A synonym, used by Henderson, and others, of pectinate ligament.

Cribrose lamina. A synonym of *lamina cribrosa,* the perforated sheet of connective tissue that stretches across the optic opening of the nerve-head.

Cribrum. Synonym of *lamina cribrosa.* See **Cribrose lamina.**

Crick dots. Gunn's dots. Occasionally, and erroneously, written "Gun's" dots, "Creek" dots and "Crick's" dots. These are small, whitish or yellowish points seen in the macular region. They are generally found in clusters, although they sometimes occur singly. They occur in young subjects and are not, as a rule, of pathological significance. The peculiar name, "Crick," was given to these deposits by Marcus Gunn (*Trans. Oph. Soc. U. K.*, 1883, Vol. 3, p. 110, illustrated; and *Ophth. Review,* 1889, Vol. 8, p. 256) from the name of the family every member of which showed these peculiar foveal anomalies. See, also, **Gunn's dots.**

Crime, Eye-strain and. Ocular defects in criminals. The exact relation between criminal tendencies and eye-strain has not as yet been satisfactorily defined. Probably too much has been claimed (on those rather rare occasions when the subject has been discussed in medical literature) for asthenopia as an incentive to crime. It is

very likely that the high percentage of ametropia and oculomuscular errors found in habitual criminals is either a coincidence or that it is part of the general bodily defects found among them.

In the *Bulletin of the Am. Med. Assocn.* for Nov. 29, 1913, the following evidence is put forward: A San Francisco schoolteacher, who had suffered much from eye troubles herself, at one of her visits to her oculist's office described an incorrigible child in her school who appeared to have some defect of sight. This suspicion had been repeatedly reported to his parents, but as they were poor as well as ignorant, nothing had been accomplished so far. She decided, therefore, to make an independent effort in the boy's behalf and solicited the assistance of her oculist's aid. There were doubts of any good accomplishments being possible, as the boy seemed both extraordinarily dull and superlatively mean. His teacher said that at the age of 11 years he was the worst child in her experience of many years in school work. He frequently played "hookey," associated with the worst boys of all ages, smoked cigarettes, swore like a trooper and lied outrageously; besides, he seemed to take a stupid pride in learning nothing and thwarting all her efforts. The only physical defect noticed was that he held print unusually close to his eyes. Examination showed one eye had two-sevenths and the other one-fifth of normal vision.

The boy was dumbly indifferent in the beginning to the eye test, but after much labor and aggravation, lenses were placed before his eyes, giving practically perfect vision at once; then he showed symptoms of being almost human. The glasses were ordered and the case gladly dismissed. More than a year afterwards the doctor saw the teacher again and inquiries were made with misgivings. The report was jubilant and astounding. She said that after she procured the glasses and had gained consent for his wearing them, the child's transformation was rapid and complete. He had become the willing slave of the teacher, where before he seemed to resent her every interest in him; he never missed a day in school, where formerly playing truant was chronic with him. He was the head of his class now, where previously he was too dull to be classed at all; he had voluntarily stopped his numerous bad habits and had become the marvel of the neighborhood as well as the joy of his parents, and so on.

The explanation of this metamorphosis is simple and natural. The child was more than three-fourths blind and no one had known it. He could not learn because he could not see, and his eyes and head undoubtedly pained him when straining to see. His incorrect and

absurd answers made the other pupils laugh at and guy him, so he hated everything connected with the school, and in playing truant he met the worst possible associates and learned from them his notable array of vicious habits. When he put on his glasses he saw the world for the first time clearly and in comfort. He therefore was able to learn and his ambition was aroused. Hence he loved schooling and the opportunity to show his real capability, and by regular attendance at school lost the bad companionship which was really responsible for his show of criminal tendencies. After the boy became the pride of the school, his parents took an interest and aided him, where before they ignored so unlovable a child. A boy who at the age of 11 was the worst child in the school and neighborhood and was absolutely callous to all moral suasion, would probably have developed into a criminal. It is no exaggeration, therefore, to say that the development of a dangerous breaker of law and order of an extreme type was prevented by a pair of glasses.

G. M. Case (*Ophthal. Record,* Vol. 15, p. 517, 1906) has also contributed an article on this subject in which he contends, from tabulated reports of various penal institutions, that the correction of prisoners' refractive errors is, and in many instances, has been followed by improvement of the mental and moral condition.

Cripte dell'iride. (It.) Crypts of the iris.

Criptoftalmo. (It.) Cryptophthalmus.

Crista lacrimalis anterior. (L.) Anterior lachrymal crest.

Crista lacrimalis posterior. (L.) Posterior lachrymal crest.

Cristal de lune. (F.) Nitrate of silver; i. e., crystals of "lunar" caustic.

Cristal de Vénus. (F.) Acetate of copper.

Cristal hématique. (F.) Hematoidin.

Cristallin. (F.) The crystalline lens.

Cristallin, Extraction du. (F.) Cataract extraction.

Cristallinien. (F.) Pertaining to the crystalline lens.

Cristallinite. (F.) (Obs.) Phakitis.

Cristallin, Luxation du. (F.) Dislocation of the lens.

Cristallin luxé. (F.) Dislocated lens.

Cristallocone. (F.) Lenticonus.

Cristalloïde. (F.) Crystalloid, *adj.* The capsule of the crystalline lens, *noun.*

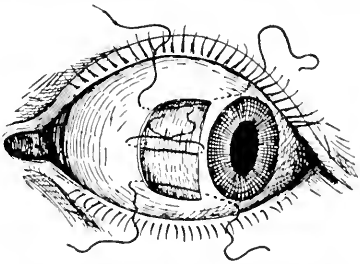
Cristalloïdite. (F.) (Obs.) A supposed inflammation of the capsule of the crystalline lens.

Cristaux de lune. (F.) Crystals of silver nitrate.

Critchett, George. A famous London ophthalmologist, inventor of

a number of useful ophthalmic operations. Born at Highgate, England, in 1817, he studied in the London Hospital, became therein, in 1839, anatomical prosector, and, a little later, surgeon. Directing his attention especially to ophthalmology, he became successively Assistant-Surgeon, Surgeon, and Consulting Surgeon at the London Ophthalmic Hospital. He was a remarkable operator, and invented *inter alia*, iridodesis, his own variety of the subconjunctival method of operating for strabismus, and the method of enucleation which still bears his name. Most of these are described in the following pages of this *Encyclopedia*. He did not write very much. In 1854 he published in the *London Lancet* "Lectures on the Diseases of the Eye" and a pamphlet entitled "Operation for Strabismus by the Subconjunctival Method;" in 1864, "The Linear Extraction of Cataract." He died Nov. 1, 1882.—(T. H. S.)

Critchett's advancement operation. The earliest form of advancement that remains today a valuable practical procedure, was first done to remedy a congenital divergent strabismus of high degree. It had been done by Critchett, but was described by Bader (*Royal London Ophth. Hosp. Reports*, Vol. 1, p. 254) in 1858. Both externi had been divided, and the eyes turned in by a thread across the nose. But at the end of a fortnight the divergence remained. An

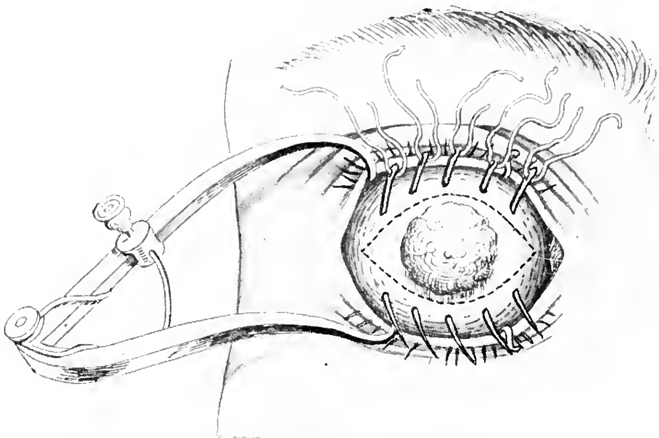


Critchett's Method of Advancement.

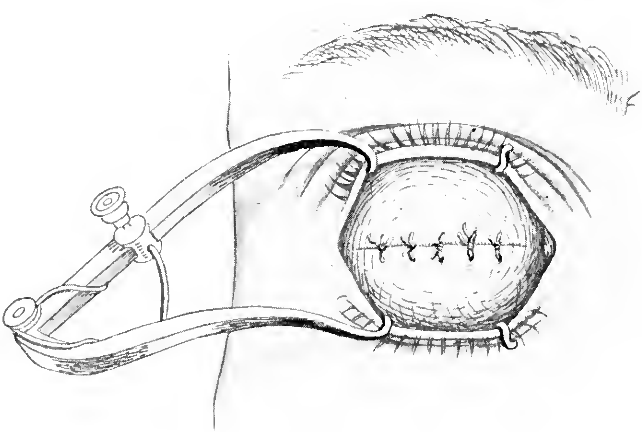
incision was made through the conjunctiva parallel to the inner edge of the cornea. "The conjunctiva, internal rectus, etc. were dissected off the sclerotic towards the inner canthus; and an oval piece of the flap being excised the wound was united by sutures, three in one eye and four in the other eye. The sutures had been drawn in before the incision was completed; they were removed in a week; no swelling or other bad result followed the operation; a very slight internal strabismus of either remains."—(Wood's *System of Ophthalmic Operations*, Vol. 1, p. 706.)

Critchett's cataract extraction. This is a slight modification of Graefe's method. See Wood's *System of Ophthalmic Operations*, Vol. 2, p. 1151.

Critchett's corneal staphyloma operation. The best-known operation for removal of the cicatricial total type of staphyloma is that of George Critchett (*Royal London Ophth. Hosp. Reports*, Vol. 4, 1863,



pt. 1, p. 1). It consists in the removal of an elliptical portion of the cicatrix and an uniting of the edges of the wound by stitches. It is only suitable in cases of total cicatricial staphylomata, espe-



cially in those "with thick walls or even button-like thickened zenith, where a restitution of vision is impossible, and it is only a question of forming a stump for an artificial eye."

General anesthesia is necessary. After the parts have been prepared, and the eyelids separated by a stop speculum, four or five needles, armed with surgeons silk, are passed through the staphylo-

matous area, and, at times, the sclera in the ciliary region, in the same manner as shown in the sketch. This done, an elliptical area, made in the points of entrance and exit of the needles, is excised by means of a Beer knife and a pair of scissors. The elliptical flap in the staphyloma removed, the free edges are brought together and tied with the silk sutures, which are allowed to remain *in situ* until the parts are well united; the period of time averaging about a fortnight. The author of the operation states that the crystalline lens must be removed at the time of the procedure. (Wood's *System of Ophthalmic Operations*, Vol. 2, p. 982.)

Critchett's iridenclesis operation. Critchett (*Trans. Ophth. Soc. of the United Kingdom*, 1892) made a small section at the corneal limbus corresponding to the site of the most transparent part of the iris. This opening was to be no larger than just to be able to grasp the iris through it with forceps. The iris, seized midway between its periphery and the pupillary edge, was slowly drawn out and tied with a fine silk thread, the long ends of the thread being left hanging outside so as to prevent the slipping back of the iris. In this manner a small pupil could be placed in the most desirable and most useful position. After 48 hours the thread and iris tissue outside the wound fall off.—(Wood's *System of Ophthalmic Operations*, Vol. 2, p. 1057.)

Critchett's operation for eversion of puncta. In those cases where eversion of the lower punctum is so great that the usual procedure of slitting the canaliculus does not cure the case, Critchett increases the effect of the operation by excising with a pair of sharp, slender, curved scissors the inner wall of the divided canaliculus and a small portion of the neighboring conjunctiva. See **Lachrymal apparatus, Diseases of the.**

Critchett's tenotomy. The so-called subconjunctival tenotomy operation, one of the oldest and best known, involves a complete section of the tendon. The description of this operation by de Schweinitz (*Text-Book*, p. 864) is as follows: "The eyelids being separated with a stop speculum, the surgeon catches with a fine-toothed forceps a fold of conjunctiva and subjacent fascia on a level with the lower border of the tendon, and with the probe-pointed scissors makes an opening just large enough to admit the strabismus hook. He may with one clip divide conjunctiva, subjacent fascia, and the capsule of Tenon; otherwise, after the division of the conjunctiva and subconjunctival tissue, Tenon's capsule must be picked up and incised in a length equal to the cut made in the overlying structures. The scissors are now laid down, and with his right hand the operator

takes the strabismus hook and insinuates it behind the tendon, the wound at the same time being held open with the forceps. After insertion the hook is pressed firmly against the sclerotic, and pushed between this and the tendon as far as the elbow of the instrument will permit. The point is then turned upward, and made to appear at the upper border of the tendon beneath the conjunctiva. It is now drawn forward and outward toward the cornea, and will be stopped by the insertion of the tendon. The operator now dispenses with the forceps, takes the hook in his left hand, renders the tendon tense, introduces the scissors, with their blades slightly parted, into the wound between the hook and the eye, and divides the tendon close to its sclerotic attachment by a number of slight cuts. After the section has been performed the hook should be swept through the opening in order to catch any strands which may have escaped the scissors. These should then be divided."

Crithe. The name (Greek) applied by Celsus to a hordeolum, or stye. Concerning the stye, or crithe, and its treatment, Celsus remarks as follows: "In the eyelids, too, is formed, sometimes, a small tubercle, which, from its resemblance to a grain of barley, is by the Greeks called 'crithe.' It is contained in a coat, and maturates with difficulty. It should therefore be fomented with hot bread, or with wax repeatedly heated to a temperature which is grateful to the parts. In this way it is often discussed, sometimes maturated. If pus appears, the crithe should be divided, and the contained humor squeezed out. The parts should then be again fomented, and also anointed, until complete recovery has occurred."—(T. H. S.)

Critical angle. The least angle of incidence at which a ray of light traveling in a denser medium is totally reflected at the surface which separates it from a rarer medium.

Critschett'sche Operation. (G.) The term generally applied by German writers to Critchett's corneal staphyloma operation (q. v.).

Crochet. (F.) n. A small hook. Tenaculum.

Crochet à strabisme. (F.) Strabismus hook.

Crochet mousse pour l'iris. (F.) Blunt hook for operations on the iris; a blunt iris-hook.

Crochet névrotome. (F.) A hook used in (the operation for optic) neurotomy.

Crocodile. Throughout antiquity and the greater portion of the middle ages, it was generally supposed, at least by the laity, that either the dung or the gall of the crocodile, made into a salve with honey, was a sovereign remedy for what was called "suffusio" or "cataract"—the latter expression having been invented by Constantinus Africanus in the eleventh century.

The blood of this animal was also supposed to remove opacities of the cornea.—(T. H. S.)

Crocomagma. This, the residue left after the preparation of saffron oil, was a favorite ophthalmic remedy in ancient Greco-Roman times. See **Saffron,** also **Crocus.**

Crocus. SAFFRON. This agent consists of the dried stigmas of *Crocus sativa.* The saffron of pharmacy is a flattened, tubular collection of thread-like stigmata, 1 1/4 inches long, of an orange-brown color, a strong, peculiar, aromatic odor, and a bitter, aromatic taste. They furnish an aromatic volatile oil, a yellow glucoside called *crocin,* and other constituents. One part of saffron will color yellow 100,-000 parts of water.

Saffron has long been used as a collyrium in the form of a colored infusion, 2 drams to a pint of water. It also enters into the *tinctura opii crocata* P. G. which, when mixed with two or three times its bulk of water, is not an uncommon eyewater, useful in chronic catarrh of the conjunctiva. The saffronated tincture of the German pharmacopeia is substantially the same as our vinum opii except that saffron is added to the mixture.

In the various forms of conjunctival catarrh C. R. Holmes uses a collyrium containing 1/4 grain of this remedy to the fluid ounce.

Cromidrosi. (It.) Chromidrosis (q. v.).

Crookes' tube. X-RAY TUBE. FOCUS TUBE. X-rays, composed of infinitesimally short transverse waves, are propagated in straight diverging lines, their mass being inversely as the square of the distance. They are produced in a Crookes' tube having a vacuum of .000001 of an atmosphere which is traversed by a high tension electrical current of a static machine or Rhumkorff coil. The tube has a cupped cathode and two anodes, one of which in line with the cathode is the anode proper. The other terminates in a flat disc (target), the anti-cathode. In connecting up the tube, the anode of the exciting machine should be connected with the anode of the tube, and not with the anti-cathode, as is often recommended.

A stream of particles probably (Guilleminot) flows from all parts of the anode end of the tube towards the cathode, receives a negative charge, is then repelled with tremendous velocity and focused upon the anti-cathode, by which it is transformed into X-rays, which are ejected through the wall of the tube in front of the target. The auxiliary chamber of the tube contains a mica disc, which, when heated by connection with the cathode cord, gives off vapor and lowers the tube. The vacuum is raised by connecting the anode cord to the platinum coil, which being heated, absorbs gas. A satis-

factory tube should show a dull spot at or near the center of the target, when used, and it should be possible to raise its vacuum in five to ten minutes, and lower it in a few seconds to five minutes.

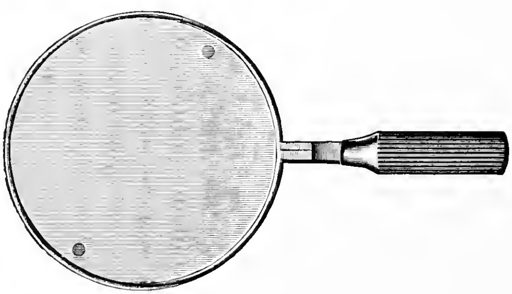
Cross, Bull's. A test for astigmatism, devised by George Bull of Paris.

Crossed amblyopia. It was Charcot (*Leçons sur les localisations dans les maladies du cerveau*, p. 114) who first claimed that the particular eye symptom set up by lesions of the posterior third of the posterior limb of the internal capsule is crossed amblyopia. This is a marked defect in vision, with a decidedly contracted field, in the eye farther removed from the disease; the field of the other eye (on the side of the lesion) being also contracted, but to a less extent. This view of crossed amblyopia is not now generally accepted.

Crossed bundle. That segment of the optic nerve fibres and tract originating in the occipital lobe of the opposite side.

Crossed cylinder. Astigmatic lens. A lens with a cylinder ground on either surface of the glass, the axis of each being at right angles to the other.

An article on the double cross-cylinder is by J. N. Rhoads (*Ophthalmic Record*, XX, p. 292).



Jackson-Stevenson Crossed Cylinder.

The Jackson-Stevenson crossed cylinder is a test of refractive errors. The sphero-cylindrical equivalent of a lens having a plus and a minus cylinder of equal strength, with axes at right angles to each other. A round, corrugated handle that may be easily held and rotated, is placed midway between the two axes so that a simple rotation interchanges the position of the two cylinders. The axis of the plus cylinder is marked by holes drilled one-half way through the lens and filled in white. The lens is used to determine whether a cylinder in the trial frame should be made stronger or weaker, or if a cylinder is required.

A more detailed description of the use of this test will be found under the caption **Examination of the eye.**

Crossed diplopia. Binocular diplopia in which the position of the double images is reversed, the left image corresponding to the right eye and the right image to the left eye. It results from divergent squint, from paralysis of the internal rectus or spasmodic contraction of the external rectus.—(Foster.)

Crossed eyes. A vulgar term for *convergent strabismus* (q. v.) or internal squint.

Crossed fasciculus. Another name for the crossed bundle of fibres in the optic nerve and tract.

Crossed hemiplegia. This symptom occurs when a cerebral lesion affects the pyramidal fibres in the crusta, along with the roots of the third nerve. This is followed by more or less loss of power in the third nerve on the same side of the lesion, with a hemiplegia and paralysis of the lower part of the face on the opposite side.

Crossed lens. A lens that produces the least amount of aberration when exposed to parallel incident rays of light. It is a biconvex or biconcave lens with a curvature of its front surface 6 times as great as that of its back surface (the greater curvature having the shorter radius). The plano-convex lens is nearly as good as the crossed lens whose aberration is only 2 or 3 per cent. less than the former; it is easier to make, and is therefore more commonly used. The crossed lens when made of flint glass, with a refractive index of 1.6, is a plano-convex lens.

Crossed sclerotomy. LATTICE-LIKE SCLEROTOMY. GRILLED SCLEROTOMY. The foregoing terms describe the operation of Wicherkiewicz (*Ann. d'Ocul.,* July, 1912) for the relief of glaucoma (q. v.). After exposing the sclera, he makes four to six parallel, meridional incisions each 10 to 12 mm. long, almost through the entire thickness of the sclera. Similar incisions are then made at right angles to these and the wound closed by two or three sutures. This operation is free from danger and indicated in simple glaucoma, hemorrhagic glaucoma and any glaucoma in which an anterior operation has proved unsuccessful. In keratoglobus, in hydrophthalmos, and in secondary glaucoma due to luxation of the lens into the vitreous, the operation is of distinct value. To obtain the best results the eye operated on should be massaged during the following nine or ten days.

Cross-eye. Internal strabismus or convergent squint.

Cross-eyed. Affected with convergent strabismus.

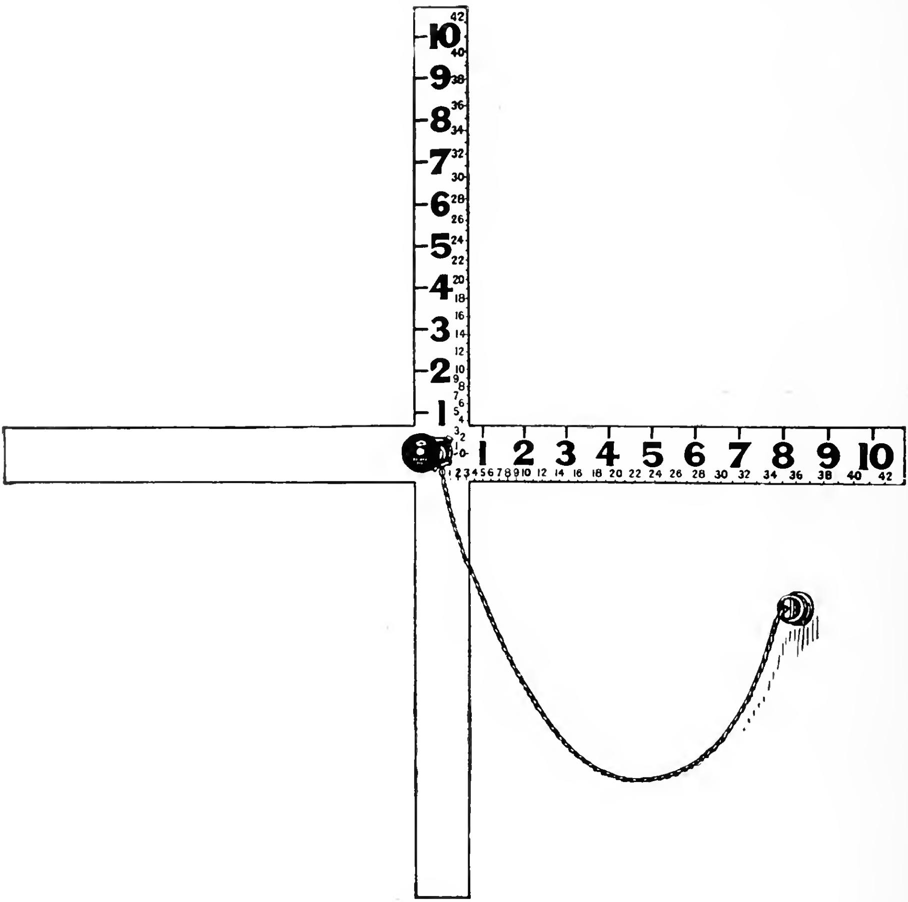
Cross-hair. CROSS-WIRE. FIBRE-CROSS. A fine strand of thread, or a pair of parallel or transverse wires or strands, mounted in the focal

plane of an optical instrument, and used as a visual test or for visual purposes.

Cross-section. TRANSECTION. A section at right angles to the principal axis.

Cross-staff. A surveying instrument consisting of two pairs of sights crossed at right angles.

Cross, The Maddox. This device is intended to measure degrees of heterophoria, or latent muscular insufficiency, at 5 metres and 1



The Maddox Cross.

metre respectively. The apparent relative positions of the two images of a diplopia induced by prisms or a red glass over one eye (or by both methods) are determined by the figures of the table.

Cross, William. An English ophthalmologist of the 18th century, concerning whom we know no more than that he wrote "A Brief Treatise on the Eye" (London, 1708). Even this book would seem to be no longer extant.—(T. H. S.)

Cross-wort. Senecio vulgaris. In the time of Pliny and Dioscorides, cross-wort, or groundsel, was employed, mixed with saffron and cold water, as a poultice for epiphora.—(T. H. S.)

Crotalus horridus. Rattlesnake. Apart from the rather doubtful stories of amblyopia following the bite of the rattlesnake, more or less reliable evidence shows that this injury has produced hemorrhage from the mouth, ears and eyes.

Crotonaldehyd. (G.) Chemical burns of the eye have been noted in at least one case by this agent. Furthermore, Homburg (*Beiträge z. Cas. u. Statistik d. Augenverletzungen*, Berlin, 1883) gives an account of a chemist who, while engaged in distilling this aldehyd, found that his eyes began to smart, a symptom followed by swelling of the lids, lachrymation, blepharospasm and hyperemia of the conjunctiva. He recovered under persistent treatment without damage to the ocular apparatus.

Croton-chloral hydrate. Butyl-chloral hydrate. This agent occurs as light, white, shiny, crystalline scales, with a pungent odor. It is readily soluble in alcohol, and slightly soluble in water. It is used as an analgesic and hypnotic in doses from 1 to 2 grams—to be taken at intervals until relief is obtained. It is distinctly poisonous in large doses. In ophthalmic therapeutics it is employed for the relief of ocular headache and the post-neuralgic pains of herpes of the lids and eyeball.

Croton oil. This is a fixed, brownish-yellow oil obtained by expression from the seeds of Croton tiglium. It is a drastic purgative and rubefacient—also a violent poison. Introduced into the human eye it immediately produces a marked smarting and, after a quarter of an hour, an acute inflammation of the lids, which soon extends to the face and eyebrows. These symptoms may last for a week or more and the inflammation may extend to, and produce haziness of the cornea. In a reported instance, a purulent ophthalmia resulted from rubbing the edges of the lids with the oil. In this case one eye exhibited an opacity of the lower half of the cornea; the other recovered entirely.—(Lewin and Guillery, Vol. 2, p. 764.)

Crounotherapy. Riesman's term for the employment of mineral waters for dipsomania.

Croupöse Bindehautentzündung. (G.) Croupous conjunctivitis.

Croupous conjunctivitis. That variety of conjunctivitis which is char-

acterized by the formation of a more or less extensive membrane upon the surface of the conjunctiva of the lids. See **Conjunctivitis, Membranous.**

Crow. The brain of the crow was eaten, in Greco-Roman times, to promote the growth of the eyelashes. (Pliny, XXIX, 37.)—(T. H. S.)

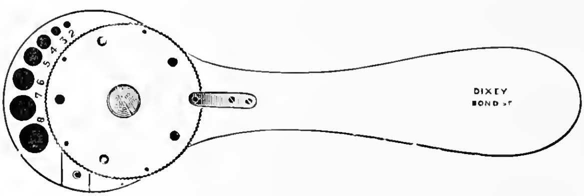
Crown-glass. A good quality of plate glass, made of fine white sand and kelp or pearl ashes, used in the manufacture of lenses, and in connection with flint-glass to correct chromatic aberration in dioptric instruments. It must not contain iron or lead.

Crown of aberration. A circle of light around the disc of the sun, due to the aberration of the solar rays.

Cru. (F.) Raw; uncooked; not softened; crude.

Cruciform. Crucial. In the form of a cross.

Cruise's central color scotometer. An instrument for testing defects in the color-field. See Vol. IV, page 2419, of this *Encyclopedia.*



Cruise's Central Color Scotometer.

Crumbhorn, Caspar. A famous blind musician, who flourished in the latter portion of the 16th century. He lost his sight when three years old. He became an excellent player on the flute, the organ and the violin; was patronized by Augustus, Elector of Saxony; was elected organist of the Church of Sts. Peter and Paul, at Lignitz; and, later, chief director of the School of Music in the same city. He died June 11, 1621.—(T. H. S.)

Crumenophthalmus. (L.) Having the eyes surrounded by a sac.

Crustaceans, Eyes of. See **Crabs, Eyes of**; also, **Comparative ophthalmology.**

Crustaceans, Ophthalmic relations of. This subject has been and will be discussed under various headings. See, for example, **Caligus** (Vol. 2, p. 1360 of this *Encyclopedia*); **Crustaceans, Eyes of**—a subheading of **Comparative ophthalmology** (Vol. IV, p. 2519 of this *Encyclopedia*). The oculo-toxic relations of the lobster, the crab, etc., will be considered as a part of **Botulism,** discussed chiefly under **Toxic amblyopia.**

Crusta lactea palpebrarum. A moist eczema of the eyelids of children.

Crustula. (L.) An old name for an effusion of blood beneath the conjunctiva.

Cruveilhier, Valve of. One of the valves of the lachrymal canals. See **Valves of the lachrymal canals**; as well as **Lachrymal apparatus.**

Crymotherapy. Ribard's term for the therapeutic use of great cold applied locally.

Cryptæ iridis. (L.) Small crypts on the anterior surface of the iris, near the pupillary margin.

Crypto-crystalline. Occurring in crystals that can not be distinguished with the naked eye.

Cryptogenetic. Of concealed or obscure origin, as of a disease.

Cryptoglioma. This is a term first applied by Schöbl (*System of Diseases of the Eye,* Vol. 3, p. 554), and described by him as follows: In extremely rare instances gliomata may exhibit a different manner of growth. At first such cases grow after the first type, enter the vitreous chamber, and may fill the eyeball and be disseminated into the choroid and the optic nerve. They then undergo regressive metamorphosis from a tendency of their own which may be favored by inflammatory processes in the eyeball, such as irido-cyclitis and chronic panophthalmitis. After the primary growth has thus degenerated, the fluid parts of the eyeball may be absorbed and the eye shrink in consequence of the inflammatory processes, so that it presents the picture of progressive bulbar atrophy or anterior or complete bulbar phthisis. After a varying interval the disseminated patches in the choroid or optic nerve, or in both, begin to grow again. They then fill the eyeball, increase its size again, break through it, and lead to the well-known end.

Cryptophthalmia. A congenital defect in which the eyeball is hidden by the palpebral skin, which stretches across the orbit without any apparent interpalpebral aperture. In some rare cases the eyes and the orbits are or appear to be absent.

Coover (*Ophthalmoscope,* Vol. 8, p. 259, 1910) has reported two cases of cryptophthalmia (See figures). The upper and lower lids were firmly united. There was a slight pitting of the skin of the upper lids containing a few cilia. In childhood the lids of the left eye had been separated and an undeveloped eyeball found present. The same condition was found by Coover on the right side. The patient was a female aged 24 years. A second case was the female

infant of the first patient, aged 7 months. On palpation the presence of a small eyeball could be determined. The lids were dissected apart disclosing an undeveloped eyeball.

Coover's First Case of Cryptophthalmia, the Mother.

Coover's Second Case of Cryptophthalmia, the Daughter.

Gutmann (*Centralb. f. prakt. Augenheilk.*, 1909, p. 263) also gives the history of a case of cryptophthalmos. The nasal half of the palpebral fissure was not developed and was covered by the skin of the forehead. The temporal half was formed and presented cilia and a shallow cul-de-sac. Behind the nasal half there was a small cyst. There was a cleft in the lip and palate and the entire right nasal cavity, lachrymo-nasal duct and canaliculus were wanting. The fissure was enlarged and an abscess, the walls of which extended to the optic foramen, evacuated. Microscopic examination showed traces

of muscle, nerve and blood vessels, but no evidences of eyeball or optic nerve were found. He believes that a rudimentary ball had been present but was destroyed through ectogenous purulent infection. Becker's case was one of clinical anophthalmos in an abnormally developed child of 17 weeks. Shiperskaya (*Russky Vrach*, Vol. 8, p. 886, 1909) records a similar case. Rochon-Duvigneaud and Coutela (*Arch. d'Opht.*, May, 1909, p. 257) record two cases of microphthalmos with hydrocephalus. There were no other malformations. Both conditions probably had their origin in an intrauterine inflammation. In the one, tuberculosis in the father was the likely cause.

Bilateral congenital total absence of both eyeballs was seen by Boulai (*Clin. Opht.*, Vol. 17, p. 124, 1911) in a child born at full term and in every other way entirely normal. The conjunctival cavity was very small (only large enough to contain a small pea), the mucosa being a purplish red and granular in appearance.

Ginzberg (*Klin. Monatsbl. f. Augenheilk.*, August, 1911, p. 211) reviews the literature and discusses the theories concerning the pathogenesis of cryptophthalmos. The only two plausible theories advanced are those of arrested development, or of inflammatory changes. The author agrees with von Hippel in his stand against the latter one because of the following reasons: No scars can ever be found microscopically. Severe inflammation of the anterior segment of the eye presumes the presence of organisms, which cannot possibly gain admission to the conjunctival sac, closed as it is before birth. Histological findings are against this theory; and it does not correspond with the clinical findings. Ginzberg describes a case of his own with the complete anatomical picture which may be briefly presented thus: No remains of any inflammation were visible, nor were any scars to be seen; no traces of conjunctiva, tarsus, Meibomian glands or ciliæ could be found; the conjunctival sac was absent; the cornea was represented by merely a connective tissue mass which contained the lens and capsule; the iris was represented by a two-cell layer of epithelial proliferation, corresponding to the early embryonal stage; the ciliary body was poorly developed, but showed no traces of inflammation; the sclera was somewhat thicker than normal, but showed the normal structure; the choroid was retarded in development and contained but few chromatophores and some of its layers could not be differentiated; there was no retina or vitreous in the eye; the anterior portions of the optic nerve were atrophic and without medullated fibres; there was an extensive coloboma of the posterior section of the eye; above all, none of the structures showed any signs of inflammation. On the basis of his observations, Ginzberg then offers a new theory

to explain the cause of cryptophthalmos. Eberhardt (*Ophthalmic Rec.*, Vol. 20, p. 4, 1911) reports a case of cryptophthalmos in which he opened the closed lids by operative procedure early in extra-uterine life. One globe was found to be of normal size, while the other was somewhat larger, but shrank to normal size within a few days. Both globes presented a dark blue appearance without any distinguishable details. There was absolutely no vision. See, also, **Congenital anomalies of the eye.**

Cryptophthalmos. Congenital union of the eyelids, usually over imperfect eyes. A person who has congenital union of the eyelids. See **Cryptophthalmia.**

Cryptosarcoma. As in the case of cryptoglioma, this term has also been used by Schöbl, to designate those cases of intraocular sarcoma the diagnosis of which is obscured by the presence of exudates in the interior of the eye. See **Cryptoglioma.**

Cryptoscope. A synonym of the flouroscope. See **Electrical appliances.**

Crystal. Substances occurring in definite geometrical forms, which are always the same for the same substance.

Crystalfeuchtigkeit. (G.) The vitreous body of the eye.

Crystalhäutchen. (G.) The capsule of the crystalline lens.

Crystallenhaut. (G.) The capsule of the crystalline lens.

Crystallic. Pertaining to crystals or crystallization.

Crystalliferous. Containing crystals.

Crystallin. A constituent (globulin) of the crystalline lens.

Crystalline body. The lens of the eye.

Crystalline cataract. Lenticular cataract.

Crystalline cones. In compound eyes, transparent cones which lie between the corneal lenses and the retinulæ, one for each lens.

Crystalline humor. Crystalline lens.

Crystalline lens. The anatomy, physiology and pathology of this important ocular organ has been fully discussed under various captions in this *Encyclopedia*. See, for example, the headings, **Anatomy of the eye**; **Histology of the eye**; **Cataract in general**; **Development of the eye**; **Congenital anomalies of the eye**; and **Comparative ophthalmology**. Further observations will appear, also, under the rubric, **Lens, Crystalline.**

Crystalline muscle. MUSCULUS CRYSTALLINUS. The crystalline lens was called by these names in 1729 by Leeuwenhoek, who believed that the fibres of the lens were really of a muscular, i. e., contractile, nature. The same opinion was held by Thomas Young in 1793 (*Observations on Vision*). Home and Ramsden, however, in the fol-

lowing year, demonstrated for all time the non-muscularity of the lens, since which occasion the terms in question have been possessed of historical significance only.—(T. H. S.)

Crystallinity. Crystalline structure.

Crystallinocapsulitis. (L.) (Obs.) Phakitis; inflammation of the capsule of the lens.

Crystallinocapsulitis anterior. (Obsolete.) Inflammation of the anterior capsule of the crystalline lens, as a consequence of perforating wound of the eyeball and capsule, with or without accompanying iritis.

Crystallinocele. (L.) Hernia of the crystalline lens.

Crystallinse. (G.) Crystalline lens.

Crystallische Feuchtigkeit. (G.) The crystalline lens.

Crystalliser. A vessel for crystallization.

Crystallitis. (L.) (Obs.) Inflammation of the crystalline lens, or more properly of its capsule.

Crystallocatapieses. (L.) Crystallocatathesis. Reclination or couching of the lens.

Crystallocataracta. (L.) A lenticular cataract.

Crystallocatathesis. (L.) Reclination (couching) of the crystalline lens.

Crystallogenic. Crystal producing.

Crystallogeny. That department of crystallography which treats of the producing of crystals.

Crystallographic. Pertaining to crystallography.

Crystalloid. A crystalline body which in a state of solution diffuses readily through such membranes as parchment paper; opposed to colloid.

Crystalloiditis. (L.) (Obs.) Crystallitis, or inflammation of the lens or its capsule.

Crystallology. The science of crystallography.

Crystallomagnetic. Pertaining to the magnetic properties of crystals.

Crystallometry. The measurement of crystals.

Crystalloparatopia. (L.) (Obs.) Displacement of the crystalline lens, or couching.

Crystallotype. A photograph on glass or any other transparent support.

Crystallurgy. The process and study of crystallization.

Cubangle. The solid angle of a cube formed by three edges meeting at right angles to each other.

Cubangular. Resembling one of the solid angles of a cube.

Cubebs. Java pepper. Tailed pepper. This is the well-known, dried, unripe, but fully grown pepper-like fruit of *Piper cubeba,* from Southern Asia. It furnishes an inert *cubebin,* a bitter, white crystalline substance. The dose of these powdered, globular, spicy berries is one-half to four grams and they have been extensively employed in "catarrh" of most mucous membranes.

The French prepare an ethereal extract called *"cubebine,"* a popular remedy for gonorrhea. When taken in large doses this preparation (as well as the powdered peppers) has caused urinary irritation, serious nervous symptoms, miosis, upturned eyeballs, coma and, just before death, dilated pupils.

Cucumber. Cucumis sativus. Cucumber was an ophthalmic remedy commonly used in Greco-Roman antiquity. The raw flesh was employed as a poultice, and Pliny particularly recommends elaterium—which, according to him, was extracted from the *Cucumis silvestris*—in numerous ocular affections. *Cucumis colocynthis,* stewed in wine, was also highly favored.—(T. H. S.)

Cucurbitularum positio. (L.) Cupping.

Cucurbitulatio. (L.) Cupping.

Cueilleurs de houblon. (F.) Hop-pickers.

Cuiller. (Cuillère.) (F.) A spoon.

Cuillerée. (F.) Spoonful.

Cuir. (F.) Leather.

Cuisant. (F.) Burning; smarting, violent (as applied to pain).

Cuisson. (F.) A smarting pain.

Cuivre. (F.) Copper.

Culbertson, Howard. A famous American general practitioner, who was also known as an ophthalmologist. He was born at Zanesville, Ohio, Feb. 24, 1828, the son of the Rev. James Culbertson and Elinor Calhoun Culbertson, both of whom were of Scotch and Irish stock. Howard Culbertson's preliminary training was received at the public schools and at Howe's Academy, Zanesville. When seventeen years of age, having great mechanical ability, he removed to Cincinnati and became a machinist. The work in the shop, however, proving too heavy, he decided to study medicine. After a brief stay with his preceptor, Dr. Little, a physician of local note, he proceeded to the Ohio Medical College, at Cincinnati, Ohio, where he took one course of lectures. His second course was attended at Jefferson Medical College, Philadelphia, Penn., from which institution he was graduated in 1850.

Returning at once to Zanesville, he entered into general practice, making, however, a specialty of ophthalmology and otology.

Soon after the war broke out, he enlisted in a surgical capacity. In the fall of 1862 he was Acting Assistant Surgeon.

Returning to Zanesville, he devoted himself again to his general and special practice with a zeal which, in spite of his feeble health, soon gave him a wide celebrity as diagnostician and operator.

He was a well-known writer on scientific subjects. He was one of the chief contributors to the *"Medical and Surgical History of the War of the Rebellion."* In 1862 he wrote an essay on "The Sin of Anesthetics in Midwifery," for which he received the gold medal of the Ohio State Medical Society. In 1876 he published his *magnum opus,* a book entitled *"Excisions of the Larger Joints of the Extremities."* Referring to this article, Professor Louis Sayre, of New York, when presenting Dr. Culbertson to his class, declared: "Gentlemen, I have the honor to present to you a man who has accomplished a task which no other man in the United States would have had the courage to undertake, or the patience to finish." This work was published as the prize essay of the American Medical Association for that year. Among his numerous ophthalmologic articles those of chief value are: "Some Thoughts on Astigmatism of Curvature" (*Am. Jour. Oph.*, Vol. III); "Four Cases of Galezowski's Extraction of Cataract" (Do. Vol. VIII): "On a Mode of Determining with the Prisoptometer the Degree of Latent Hypermetropia without Mydriatics" (Do); "A Mode of Determining the Absolute Myopia through the Aid of Glasses with the Prisoptometer" (*Ibid.*); "On the Application of Cylindrical Glasses in Spasmodic Myopic Astigmatism" (*Ibid.*, Vol. II); "A Case of Glaucoma, Illustrated with Microphotographs" (*Ibid.*, Vol. IV); "A Case of Iridochoroiditis with Sympathetic Irritation of Fellow Eye" (*Ibid.*, Vol. IV); "On the Influence of the Removal of the Punctum Prox. and Greater Correction with Convex Glasses in Hyperopia" (*Ibid.*, Vol. V); "Binocular Astigmatism" (*Ibid.*, Vol. V). He was also one of the Assistant Editors of the *"American Journal of Ophthalmology."*

For several years he was Professor of Ophthalmology in the Columbus Medical College, Columbus, Ohio.

Then, too, he was a very busy and successful inventor of general surgical and ophthalmological instruments. Thus, he devised a meerschaum probe for bullets, used for a time in the U. S. Army, and the prisoptometer which bears his name today. He also invented numerous ophthalmologic knives, forceps, and specula.

Nov. 16, 1854, he married Maria Louisa Safford, daughter of Dr. Elial T. Safford, of Parkersburg. Va., and of the union were born

seven children. One of these, Louis R., also became an ophthalmologist, and practised in Zanesville.

Dr. Howard Culbertson died at Zanesville, June 18, 1890, as a result of the infirmities acquired in the services of his country. Indeed, he was a very patriotic man, and was often heard to say, "Had I a dozen lives, I would lay them down willingly for my native land."—(T. H. S.)

Cul-de-sac, Conjunctival. FORNIX (GERLACH). FOLD OF TRANSMISSION. FORNIX CONJUNCTIVÆ. These terms are applied to the parts and the locality where the conjunctiva of the lid is reflected upon the eyeball—there to become the ocular conjunctiva. Dwight (Norris and Oliver's *System*, Vol. I, p. 122) says that when the eyes are open the fornix is about thirteen millimetres from the edge of the upper lid, while it is but nine millimetres from the lower lid. On the sides, also, the sac varies in depth, forming at the lateral angle a shallow pocket five millimetres deep, but at the medial angle becoming almost obliterated by the semilunar fold, under which it passes for only two millimetres. The fornix is five millimetres from the orbital rim above, six millimetres below, and four millimetres at the lateral angle. (Gerlach.) Its distance from the cornea is stated by Testut to be ten millimetres above, eight millimetres below, fourteen millimetres at the lateral angle, and seven millimetres at the medial angle. Merkel gives the distance above as eight millimetres; below, ten millimetres. It doubtless varies considerably with the prominence of the eyes.

Restoration of the cul-de-sacs.—Hotz, of Chicago, and May, of New York, were pioneers in this branch of surgery in this country, and their first successful work was reported about 1897. Since that time there has been little change in either methods or results. With slight variation of technique, but without change of principle, these operations are performed as follows: The lid is thoroughly dissected free from its attachment to the globe and the cul-de-sac is made large in all dimensions, all cicatricial bands being severed. The plate which is to hold the graft in place is now fitted. This plate is the keystone of the operation. It may be made of porcelain (May), sheet lead (Hotz), block tin (Woodruff), hard rubber (Weeks), celluloid (Haitz), or of some soft metal covered with paraffin (Wilder), but it should always be large enough to entirely fill the new socket. After the size and the shape of the plate have been satisfactorily arranged, the graft is taken from the inner side of the arm and transferred directly to the plate, where it is folded over the edges with the raw surfaces out. The plate and graft are then placed in the newly prepared socket and the lids closed over them and held in that position either by sutures

or strips of adhesive, over which is put the usual dressing and bandages. It is essential to keep the lids as quiet as possible and to this end both eyes are kept bandaged until the grafts have become firmly adherent, which requires from 4 to 6 days. At the end of that time the plate is removed but the eye is kept bandaged for a few days longer. It is well to cut an opening in the centre of the plate for purposes of observation and cleansing. When the globe is present this opening should correspond in size to that of the cornea, thus obviating pressure of the metal upon it and permitting its condition to be seen. When the globe is absent some operators make two holes, about 5 mm. in diameter and 15 mm. apart, to furnish drainage and means of irrigation before the plate is removed. The author has found that a single opening answers all these purposes, and is preferable in extensive restoration because it does not occupy space needed for the grafts.

Weeks, in 1904, reported an elaboration of the ordinary plate method of grafting, whose good results he attributes to the fact that the graft is attached to the periosteum at the rim of the orbit.

The case then reported was one of anophthalmos with obliteration of the socket. A free canthotomy was made and the lid detached almost to the rim of the orbit. Into this new cul-de-sac was placed a large Wolfe graft folded upon itself so that the raw surface covered the wounds on the stump and lid. Sutures passed through the bottom of this crease were also put through the periosteum of the orbital rim and out on the cheek. This draws the graft down into the bottom of the fornix, where it is further maintained by means of the plate which is inserted after the edges of the graft have been sutured to the stump and conjunctiva of the lid. The last step is the closure of the canthotomy. The deep sutures are left in for fourteen days, those of the conjunctiva and stump one week. The plate is left in position until all shrinkage of the flap ceases.

There seem to be many advantages gained by using the plate and no dangers. For it is claimed that (1) it enables one to accurately place the graft in position; (2) it holds it in position at the very bottom of the cul-de-sac; (3) it secures accurate and firm approximation of the whole extent of the graft; (4) it secures a greater degree of immobility and rest for the parts during the process of repair than any other method.

In addition to these merits, common to all plates, the following are claimed for that of metal coated with paraffin. It possesses greater smoothness and is less irritating to the cornea, may be easily built up to appropriate form and thickness and furnishes a bed upon which the graft is more easily spread out than upon naked metal, rubber or

porcelain, and is unaffected by the secretions of the eye. Large metal plates may be cut in two to facilitate removal. Wilder, the originator of the paraffin-coated plates, advises the use of paraffin of a melting point not lower than 130° F.

When the restoration is extensive, as in obliteration of the socket with anophthalmos, in view of the inevitable shrinkage of the newly formed cavities, it is important that the fashioning of the cul-de-sacs and of the paraffined plate, be done on a large scale. To this end it is essential to make provisional canthotomy the first step. This act serves two purposes, (1) it opens up the field of operation and (2) it permits the insertion of a much larger plate than could otherwise be employed. When the time comes to remove the plate either the canthus is again divided and subsequently resutured or else the plate is cut in two by means of strong, blunt-ended seissors.—(W. H. W.)

Wiener (*Trans. Sec. on Ophth.*, A. M. A., 1908) has also described a modified operation for restoring the conjunctival cul-de-sac, for the insertion of an artificial eye. He dissects up the available conjunctiva so that it can be used to line the lid, and carries the dissection down until a deep sulcus is formed. Then three sutures are introduced in the free conjunctival margin with a needle at each end. These are passed from within outward through the lid, and a button placed on the surface of the cheek, over which they are tied. To cover the raw surface thus left Thiersch grafts are taken from the thigh, and placed on a properly fitted lead plate covered with paraffin. Each day the sutures are drawn tighter until they cut through, leaving a deep cul-de-sac. Meyerhof (*Arch. of Ophth.*, March, 1908, p. 213) has written on lid formation and transplantation in ophthalmic practice. He prefers the method of using a flap with a pedicle.

Zeeman (*Klin. Monatsbl. f. Augenheilk.*, February, 1911, p. 204) has likewise given his experience in the plastic formation of an inferior cul-de-sac.

Cul-de-verre. (F.) The greenish appearance of the pupil in horses with cataract.

Culex giganteus. Gnat. Mosquito. The damage done to the eye by the stings of this and similar insects is generally confined to edema and localized inflammation of the lid skin, or conjunctiva, although it sometimes ends in suppuration of the part affected. The *treatment* consists in the early external use of iced fomentations with lead water. The complications, if any, are to be treated *secundum artem.*

Cullet. Ladled glass. Broken crown-glass intended for re-melting.

Culture-cell. A microscope cell adapted for the culture of bacteria.

Culture-tube. A tube specially prepared for the growth of artificially developed bacteria.

Cumarin. TONKA-BEAN CAMPHOR. CUMARIC ANHYDRIDE. This odorous agent is the active principle of the Tonka, or Tonquin bean, in which it is found to the extent of two per cent. It appears as colorless, prismatic crystals, having a fragrant odor (like vanilla) and a bitter, aromatic taste. It has been employed in eye disease in conjunction with iodoform, whose disagreeable odor it disguises in the production of the deodorized variety of the latter.

Cumin seed. The seed of *Carum carvi.* Cumin, or caraway seed, were used in ancient Greco-Roman times as a remedy for "black eye" and epiphora.—(T. H. S.)

Cuneiform cataract. This is a very rare variety of congenital cataract (See figure, Vol. II, p. 1472) in which—as the name suggests—the opacity takes the form of a *wedge,* with its base applied to the equator of the crystalline and its apex reaching to the centre of the lens. Dor observed a case in which the visual acuity was excellent although there was a paresis of accommodation. He believes this curious anomaly can only be explained by a developmental defect of the vascular capsule.

Cuneus. A wedge-shaped lobule on the mesial surface of the occipital lobe of the brain lying between the calcarine and internal parieto-occipital fissures. In this neighborhood is situated the cortical centre for vision.

Cunier, Florent. A celebrated Belgian ophthalmologist and the founder of Belgian ophthalmology. Born at Belveil, Belgium, in 1812, he died in Brussels April 19, 1852—having, therefore, lived only forty years. In spite, however, of his brief existence, he accomplished many things. In 1840 he established at Brussels an ophthalmologic clinic, which attained a great celebrity. Partly owing to his efforts, atropin and hyoscyamin came into general ophthalmologic use. He was one of the first (but *not* the very first) to perform the strabismus operation, as well as complete division of the orbicularis muscle for spastic entropion. He wrote a large number of excellent articles on ophthalmologic subjects for general and special journals, and, finally, founded, and for some years edited, the justly celebrated *Annales d'Oculistique.*—(T. H. S.)

Cunningham fusion pictures. The box of pictures provided is to be used with the red and green glasses employed in the Snellen test for binocular vision. The pictures themselves have been designed as a simple form of exercise for improving defective vision, which can be carried out as easily in the patient's own home as in the consulting

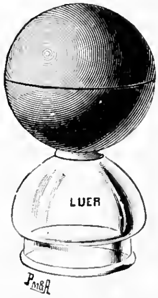
room. The colored glasses or celluloid are to be worn over lenses correcting any error of sight.

These pictures are intended to maintain or stimulate vision in each eye individually. In a young child with defective vision in one eye and good or fair in the other, the child can be taught to realize that it can see with the squinting eye, as well as with the sound eye; should there be fair vision in both eyes then that can be maintained. With the red glass over one eye and the green over the other, the child will become accustomed to the colored glasses and the pictures, and whilst unable to obtain binocular vision, will be able to see the same picture, e. g., horse, in different colors, that is first white then black, especially if an opaque object be held before each eye alternately; by reversing the colored glasses the color of the object viewed by each eye is, of course, reversed. Thus the patient is taught to be able to see with the defective as well as with the sound eye. The child being now accustomed to the glasses and books and instinctively realizing its ability to see with the defective as well as with the sound eye, the second series is employed, the principle of which is that one part of the picture can only be seen by one eye, the other part by the other eye, and the whole picture by both eyes together, but at the same time that part seen by each eye separately forms a more or less complete picture itself; thus the patient learns the necessity of using both eyes simultaneously in order to see the whole picture.

Cup, Optic. A name for the secondary optic vesicle. See **Development of the eye.**

Cup, Physiologic. PHYSIOLOGICAL EXCAVATION. VASCULAR FUNNEL. The depression (sometimes a distinct and deep funnel-like cavity) in the normal nerve-head due to a divergence of the optic fibres as they pass into the retina.

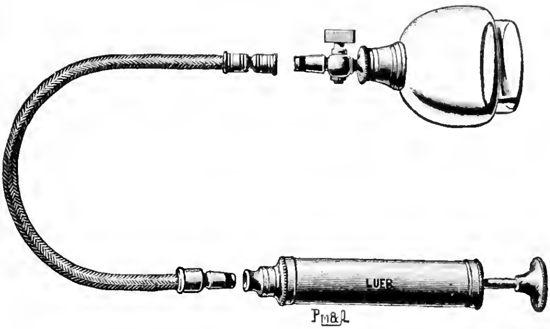
Cupping. The operation of applying cup-glasses, with scarification



Bier's Temporal Cupping-glass for the Temples, with Rubber Bulb.

or other form of dermal removal (wet cupping or leeching) or without this addition—dry cupping. A rubber "cup," or a glass cylinder

attached to one, and a small lancet are all that are needed for this operation. The skin of the temple is lightly scarified by criss-cross incisions and the blood drawn by suction. The cup of the Victor or other machine, used in giving massage, may be used. Dry cupping is occasionally recommended for the relief of ocular pain. See, also, Vol. II, p. 1226 of this *Encyclopedia.*



Cupping-glass Pump, with Intermediate Tube.

Cupping of the disk. CUPPING OF THE NERVE HEAD OR PAPILLA. This condition is generally spoken of as pathologic, as opposed to the physiological excavation (see **Cup, Physiologic**) elsewhere described. It is seen in atrophic changes in the nerve-head and especially in long-standing cases of glaucoma. In the latter case the ophthalmoscope reveals an excavation complete to the scleral margin. The edges of the pit are clear-cut and abrupt; the central vessels are crowded to the nasal side of the disc; they bend over its margin and are lost to view, afterwards reappearing (but less distinctly seen) at the bottom of the cup.

Cuprargol. A cupronucleinic acid compound, occurring as a gray powder, slowly soluble in water. It is used in the treatment of conjunctivitis in 1 to 5 per cent. solutions once or several times daily; in trachoma it is used as an astringent in 20 per cent. aqueous solution.

Cupriaseptol. A name for copper sulphocarbonate.

Cupri sulphas. See **Copper sulphate.**

Cuprocitrol. CITRATE OF COPPER. $C_2C_6H_4O_7+2H_2O$. This salt is a greenish powder, slightly soluble in water.

This salt is here given its proprietary name as it is best known as a remedy for trachoma, introduced by Merck and recommended as a 5 to 10 per cent. ointment; also with the glycerite of starch.

Lucien Howe prescribes ten parts of copper citrate to one hundred parts of petrolatum as a daily application in the granular forms of conjunctivitis with very good results.

L. D. Brose finds the following mixture dusted into the eyes morning and afternoon, followed by massage, to be useful in chronic trachoma:—Pulv. cupri. citratis., 1.00; pulv. sacchari. alb., 10.00. He says that it is much less painful than many other applications used in this disease.

It is a valuable substitute (generally employed as a 5 per cent. solution) for bluestone in the treatment of trachoma and allied diseases. von Arlt also uses it in place of silver nitrate in the form of a 5 to 10 per cent. salve made with glycerin and starch. He applies this mixture (which the patient can easily continue at home) two or three times daily on the end of a glass rod and rubs it into the conjunctival sac. The lids are then closed and massage is employed for about half a minute. The pain is slight and transient. He refers to three cases of pannus in which the trouble disappeared in from seven to twelve days. It is to be avoided in corneal ulcers and also when the individual is taking iodide of potassium.

Cuprol. Copper nucleoid. Copper nucleinate. This agent occurs as a fine powder. It is an organic compound of copper and nucleinic acid, which contains about 6 per cent. of metallic copper and is readily soluble in water. In solutions containing albumen no coagulation is seen on the addition of cuprol. The 10 per cent. solution is generally used, to which it is well to add ½ per cent. of chloretone. It is best to make the solution in warm water. From a solution of this strength there is practically no pain when dropped into the eye, and the minimum amount of conjunctival irritation. Sometimes, after ten or fifteen minutes, a slight burning may be felt, but this is only transient.

This remedy is of value in simple catarrhal conjunctivitis and in trachoma with pannus. It may be used as a powder, as a 5 per cent. solution or as salve.

Ray H. Dean employs a 5 per cent. solution in the prolonged treatment of trachoma. He prescribes it dissolved in normal salt solution and directs the patient to instil a single drop of the solution into the conjunctival sac once a day. The lids may, also, be everted and the applications made directly to the conjunctiva with a cotton swab. He orders this remedy especially for persons who live so far away that they cannot come to the office for frequent treatments. As the mixture decomposes readily he prescribes just enough to last for one week.

Cuprum aceticum. See **Copper acetate.**

Cuprum aluminatum. See **Lapis divinus.**

Cuprum ammoniatum. Ammoniated copper. Ammoniosulphate of

COPPER. $Cu(NH_3)_4SO_4, H_2O$. This is a deep blue salt, with an ammoniacal odor, which readily loses its ammonia and is converted into the non-crystalline form of cupric sulphate. Its only interest to us lies in the fact that very weak aqueous solutions (1:500 to 1:1000) have been used in purulent conjunctivitis.

Cuprum sulfuricum. (G.) Sulphate of copper.

Cura consecutiva delle operazioni. (It.) Postoperative treatment.

Curare. URARI. WOORARI. WOORALI. WOURALI. TUBECURARE. This agent is a native extract from various species of Strychnos, *Strychnos toxifera,* for example. It is a resinoid substance used by different South American Indian tribes as an arrow-poison. It appears in commerce as a blackish, brittle extract which varies much in strength. Its active poisonous properties depend upon an alkaloid, *curarin,* which exerts its paretic action on the peripheral endings of the voluntary motor nerves. It is generally given, when used as a nervine, antitetanic, etc., in doses of one-twelfth of a grain.

It has no particular use in ophthalmic therapeutics, although it produces miosis by causing accommodative spasm. Galezowski found that the instillation of a collyrium of curare into the conjunctival cul-de-sac of rabbits produced anemia of the papilla. Experiments on the pigeon and the hen show that a few drops of a 1 per cent. solution of curarin cause a marked enlargement of the pupil and immobility of the iris for several hours. Meyer believes that this curare-mydriasis is the result of a paresis of the oculomotor endings. Högyes (*Arch. f. exper. Path.,* Vol. 16, p. 92) found that the instillation of a solution of curare into the eye also produces a paresis of the external ocular muscles.

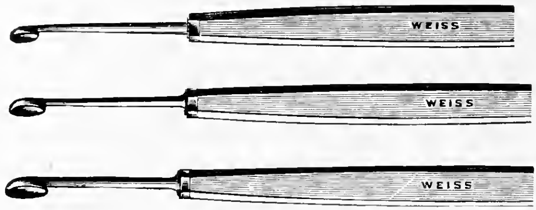
Subcutaneous injection of 0.05 to 0.135 gram of curare produces in man disturbance of vision, probably due to a partial paresis of accommodation. After the injection of large doses (0.1 gram or more) diplopia has been noticed, with a well-marked exotropia and (generally) a mydriasis accompanied by blurred vision.

Curative iridectomy. THERAPEUTIC IRIDECTOMY. When excision of the iris is done for the relief of a chronic or recurrent iritis, glaucoma, etc., it is to be considered as a therapeutic measure—hence these names.

Curd soap. Tallow or animal soap, made from tallow or suet and sold in very light-grayish masses or cakes.

Curette. CURET. An instrument for removing foreign bodies, granulations, morbid growths, accumulated secretions, etc., from the surface or accessible passages of the body by scraping. It is generally made

in the form of a bowl, spoon or ring. The accompanying cuts picture several varieties of this instrument.



Curettes for Corneal Ulcers and Tarsal Cysts.

Curette courbe. (F.) Curved curette.

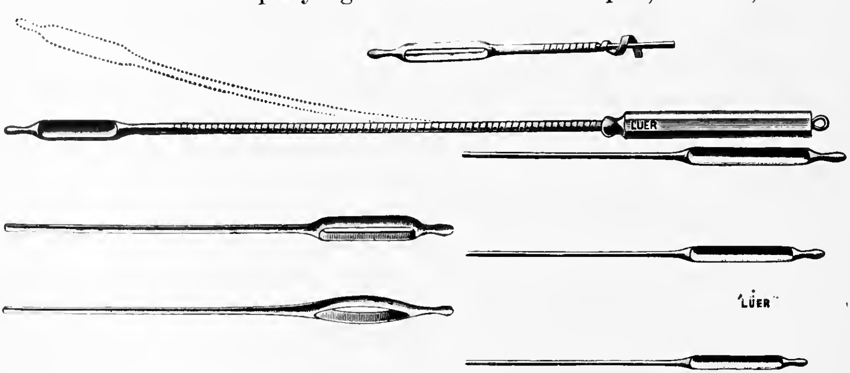
Curette, Dohnberg's conjunctival. As shown by the illustration, this instrument is intended to be used for the removal of growths on the conjunctival surface—especially the granulations of trachoma.

Dohnberg's Conjunctival Curette or Raspatorium.

Curette, Lagrange's conjunctival. This instrument, like the foregoing, is intended for the scraping of outgrowths, like trachoma bodies, from the conjunctival surface.

Lagrange's Conjunctival Curette or Raspatorium.

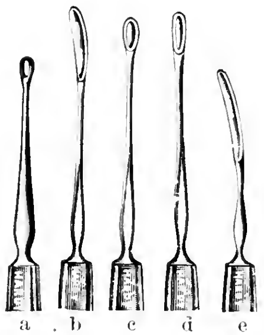
Curette, Tartuferi's lachrymal. This device—a guarded curette—is shown in the accompanying cut. It is olive-shaped, flexible, and of



Tartuferi's Sharp Curettes for the Lachrymal Canal.

three sizes, and is intended to be introduced into the nasolachrymal canal for curetting its lining membrane.

Curetting. CURETTEMENT. CURETTAGE. This procedure is most commonly employed in ophthalmic surgery in corneal ulcers, various cysts, furuncle of the lid, in exenteration of the orbit and for the removal of trachoma follicles and exuberant granulations from the conjunctiva and elsewhere—all of which are considered under their proper headings. Here the treatment by curettage of corneal ulcer may be mentioned.



Ophthalmic Curettes of Various Shapes and Sizes.
a, Wescott's corneal curette; b, de Wecker's curette; c, Helbra's curette; d, Fenestrated curette; e, Daviel's long curette.

The treatment of corneal ulcer by curetting probably dates back to the middle ages; the use of knives, spuds or stiff brushes for the removal of dead or sloughing tissue having been commonly resorted to at an early date.

The sharp spoon-curette is modern. It varies in size and shape, as shown in the figures. Great care should be taken before using to see that it is sharp and properly sterilized, as from its shape it is difficult to keep clean.

Knapp (Norris and Oliver's *System of Diseases of the Eye*, Vol. 3, p. 822) advocates its use in pustules of the cornea, round or oval, with gray or yellow deposits of inflammatory products; marginal small infiltrations, which, if unchecked, coalesce and form crescentic, annular, progressive ulcers; those irregular, progressive infiltrations of the cornea, which, starting at or near the centre, show in different places denser white or yellowish spots, known under the name of dendritic, serpiginous or malarial keratitis; other disseminate, punctate infiltrations, evidently of bacterial origin, for instance, tuberculous or trachomatous.

A drop of solution of fluorescin, or some other staining fluid, should be dropped into the conjunctival sac and the lids closed until the smarting, occasioned by its use, has subsided; the excess of the stain

should be washed away with sterile water. A local anesthetic is now used two or three times until perfect insensibility is induced.

The lids may be held apart by the fingers of the operator's own hand or by those of an assistant. The stained tissue should now be thoroughly scraped away. In deep ulcers care must be taken not to perforate the floor, remembering that the infiltrated tissue stains a little beyond the diseased portion. When the ulcer is large and considerable diseased tissue is to be removed, a fine stream of sterile water from an irrigator should be thrown on it after the curetting—not at a right angle with the plane of the cornea, but sideways, at an acute angle. In some cases it will be necessary, if the infiltrate is covered, to remove the covering with the point of a sharp knife. As soon as the ulcer looks clean from the curetting, its whole surface should be touched with tincture of iodine or some other germicide. A drop of olive oil applied will lessen the irritation. This treatment may have to be repeated if the ulceration still shows activity. Subsequent treatment with atropin and other collyria should be used. When hypopyon is present and tends to increase, corneal puncture will have to be done in addition to the curetting. The only *complication* likely to occur is in deep ulcers, when we have been too energetic, have perforated the cornea and a prolapse of iris takes place. Should this occur the iris should be immediately drawn out through the rupture and excised.—(H. B. C.)

Curling-iron burns of eye. Serious lesions of the lids and eyeball—especially of the cornea—have been produced by this instrument. They do not in any particular respect, differ from burns by similar red-hot metallic bodies, and should have the same treatment. See **Injuries of the eye.**

Current, Abterminal. The secondary electric current observed at any point in the nerve or muscle on the passage of a single induction shock.

Current, Adterminal. The negative current observed at any point in a nerve or muscle on the passage of a single induction shock.

Current, Anelectrotonic. The electric current observed at the anode on passage of a constant current through a nerve.

Current, Catelectrotonic. That electric current observed at the kathode on passage of a constant current through a nerve.

Current, d'Arsonval's. In electric science, the high potential discharge of a condenser through a large solenoid of wire.

Current, Eye. The normal electric current that passes from the

cornea (positive) to the optic nerve (negative) under the stimulus of light. See **Eye current.**

Current-interrupter. A rheotome.

Current, Intraocular. This subject has been discussed under **Circulation of the intraocular fluids,** Vol. III, p. 2256 of this *Encyclopedia.* It may be added under this caption that Kuschel's theory (*Zeitsch. f. Augenheilk.,* Vol. XXV, p. 462, 1912) of the interchange of intraocular fluid seems to receive further support from two additional cases. In the first the eye had become blind from retinal detachment in high myopia. A posterior synechia had closed off all the pupil except a small gap in the upper nasal quadrant. Nevertheless, the tension of the eye had been normal. When seen fourteen days after a fall on the head, tension was plus 2 and the anterior chamber was partially filled with blood. With the patient erect a delicate stream of blood could be seen to flow from the iris at the upper angle of the anterior chamber. But the collection of blood neither increased nor decreased in size, so that drainage at the angle was well maintained permanently. Iridectomy, not peripheral, gave relief from the glaucomatous symptom. The obstruction was probably due to traumatic stirring up of the old iridocyclitis, and rise of tension in the vitreous. The iridectomy cured by allowing a re-establishment of the current through the ciliary canals. In the second case two iridectomies and a sclerotomy were done on account of attacks of acute glaucoma following a blow on the eye. Several days after the last operation some irregular masses of exudate were discovered on the lens capsule in the peripheral part of the iris coloboma. These masses were gradually separated and absorbed by repeated massaging of the globe. The author believes that a further lowering of the tension followed the separation of each fragment of exudate, and he regards the exudate as having been the real obstruction to the interchange of intraocular fluid.

Current, Morton's. The high potential, high frequency current first described by Wm. J. Morton, whose claims to priority consist in (1) the first intermittent and graduated flow from a static machine, in which the pulses are so frequent that their aggregate may be classed as a current; (2) the first apparatus to make effective a static machine having the advantages of very high frequency and oscillatory or alternating characteristics, without the disadvantages of subjecting the patient to the direct action of the primary or interrupted current.—(Gould.)

Currents, Convection. This term is used by Türk (*Klin. Montsbl. f. Augenheilk.,* March, 1911, p. 300) who has proved on the cat, dog,

guinea-pig, dove, hen and frog the existence in the anterior chamber of these currents, resulting from the warming of the aqueous at the posterior wall of the chamber, and its cooling at the anterior wall or cornea.

Current, Sinusoidal. An alternating, induced electric current in which the electro-motive force is so varied that its rise and fall in a positive direction are immediately succeeded without a break by an exactly corresponding fall and rise in the negative direction, and the rise and fall in both directions would, if graphically illustrated, describe a sine curve. (Gould's *Dictionary.*) See **Electricity in diseases of the eye.**

Curriculum, Ophthalmic, in medical schools. See **Pedagogy, Ophthalmic.**

Curtis, E. M. A well-known California ophthalmologist. Born at Warren, Vt., Feb. 16, 1840, he began to study medicine in the University of Vermont. The war breaking out, he left school and enlisted in the army. Having served out the time for which he had enlisted, he returned to the University, and, though seriously handicapped by tuberculosis acquired in his military service, he received his degree in 1862. In 1863 he re-entered the army, this time as Assistant Surgeon, and in 1864 was promoted to the grade of Brigadier Division Surgeon. After the war he went to New York to study ophthalmology and otology.

In 1871 he removed to California, and, settling in Sacramento, hoped to get rid of his tuberculosis. For some time he practised in that place, but, becoming steadily poorer in health, he took a trip to Australia, where, however, he died May 12, 1874, aged 34 years.

Dr. Curtis was a man of great energy and enthusiasm. He performed a rather large number of ophthalmic operations, and wrote several excellent articles on ophthalmologic subjects. Among these were "Tobacco Amblyopia"; "Why Do We Wear Spectacles" (1872); "Why We Become Deaf" (1873); "The Use of Atropine in Ophthalmic Practice" (1873). He was a warm adherent of the view that the so-called "Tobacco Amblyopia" is, in reality, produced by alcohol.—(T. H. S.)

Curtis, Sir John Harrison. A celebrated English otologist and ophthalmologist. Born at Uxbridge in 1778, the son of a well-known surgeon, he practised ophthalmology and otology in London for many years. His various official positions and other dignities appear with sufficient fulness in the title of his work on the eye, which, as No. 3 hereunder, is given *in extenso.*

His most important writings were:

1. A Treatise on the Physiology and Diseases of the Ear. (London, 1817, 1818, 1836.)

2. Cases Illustrative of the Treatment of the Diseases of the Ear, both Local and Constitutional. (London, 1818. Ger. trans., Leipsic, 1819 and 1823.)

3. A Treatise on the Physiology and Diseases of the Eye: Containing a New Mode of Curing Cataract without an Operation; Experiments and Observations on Vision, also on the Inflexion, Reflexion, and Colors of Light; together with Remarks on the Preservation of Sight, and on Spectacles, Reading-Glasses, &c. The first edition appeared in 1833; second edition, 1835.

This last book is a strange compound of curious, even nonsensical, theory, with sound common sense and most excellent science. The essence of the theory is clearly set forth in the following somewhat startling paragraph:

"In relation to affections of the eye, I shall here merely add, that I conceive them to be all nearly the same disease, varying only in situation and degree, and that they are derived from similar sources. Still, we are not to consider them all as absolutely alike, and requiring precisely the same treatment; but must endeavor to trace the cause of disease, arrest it in its progress, and restore the healthy functions. The late Mr. Abernethy also thought so, and in his treatment he was generally right.

"These affections most commonly arise from derangement of the digestive organs, acting on the abdominal ganglia and great sympathetic nerve, which has such an extensive influence on the whole system. It is from medical men not bearing this in mind, that cases are often found so troublesome, and even deemed incurable."

Nevertheless, in the matter of treatment, Curtis's book is sometimes extremely rational. Thus: "With regard to the recovery of ophthalmic patients, as it is evident from the case of the slave-ship, detailed at length by M. Guillie, that want of air, close confinement, bad provisions, and scarcity of water, were the causes that first gave rise to it among the slaves, and afterwards rendered it contagious among the crew—so I think it may be asserted, that scarcely any thing tends more to stop the progress of the disease, and promote the recovery of those afflicted, than pure air and exercise. And probably one of the main reasons why the ophthalmic patients sent to the Hospital at Haslar so speedily recovered, is, that they had a good airing-ground, nearly a mile in circumference."

For a man of so great prominence in the world of ophthalmology, Curtis was remarkably ignorant of even the rudiments of the history

of his subject. Thus, he describes as his own invention a pair of strabismus spectacles "fitted with convex horn having a small aperture in front only large enough to admit light to the center of the pupil; so that the squinter, if he wishes to see at all, is obliged to accustom himself to look straight forward." We cannot properly censure even an oculist to the King for lack of knowledge of the strabismus operation in 1839, when such a procedure was not to be devised till more than four years afterward. Still, it would seem that almost any ophthalmologist, even of the year in question, should have known of the utter uselessness of horn-disc spectacles in the treatment of strabismus, as well as of the fact that this device had been conceived and used by no less a personage than Ambroise Paré far back in the sixteenth century.

The most important feature of the book would seem to be its comparative ophthalmic anatomy and physiology, which, so far as I am able to determine, were the best by far since those of Aristotle and As-Sadili *(q. v.)*. Inasmuch as this division of the work is brief, clear and important, the passage is given *in toto*: "A sensibility to the impressions of light is common to all those animals which in a natural state are exposed to this element; it appears at least very evidently to exist in some of the most simple zoophytes, as the armed polypes; but the power of perceiving the images of external objects is confined to such as are provided with eyes for the reception of those images. Nature has bestowed on some species, even of red-blooded animals, a kind of rudiment of eyes, which have not the power of perceiving light, as if in compliance with some general model for the bodily structure of such animals. This is exemplified in the blind rat among mammalia, and in the *myxine glutinosa* among fishes. As the eye is a very complicated organ, particularly in the red-blooded animals, I shall first speak of those peculiarities which affect the globe itself, its membranes, and humors; and afterwards consider the surrounding parts, as the eyelids, lachrymal passages, &c.

"*Mammalia.* It has been known that the sclerotica in several quadrupeds of this class, as in the human subject, is not of equal strength throughout; but that its posterior is much thicker than its anterior part. It has also been conjectured that this structure might influence what are called the internal changes of the eye, by which the form of the eyeball, and consequently the length of its axis and the respective situation of the lens, are adjusted according to the proximity or remoteness of the object, or in reference to any other relations. Warm-blooded animals have not only the power of seeing at various distances, but also in two media of such different density as air and

water. In the eye of the Greenland seal, where M. Blumenbach first noticed the fact, the cornea was thin and yielding, the anterior segment of the sclerotica, or that which is immediately behind the latter membrane, was thick and firm, its middle circle thin and flexible, and lastly, the posterior part very thick and almost cartilaginous. The whole eyeball is surrounded with very strong muscles; hence we can easily understand how their action, varied according to circumstances, produces the requisite changes, and how the axis of the eye is shortened when the animal sees in air, by bringing the lens nearer to the back of the globe, in order to obviate the strong refraction which the rays of light experience in passing from the thin medium of air into the thicker one of the eyes, and *vice versâ.*

"The sclerotic coat of the cetacea is distinguished by the great thickness of its posterior part: when the eyeball equals an orange in size, the back of this membrane is an inch thick, so that, although the globe is spherical, the space containing the vitreous humor is of a different form. As the sclerotic approaches to the cornea it becomes thinner. Its posterior part presents a singular structure, consisting of very firm tendinous threads and laminæ, mostly closely interwoven, and of more than cartilaginous hardness towards the sides. The extent of the cornea, when compared to that of the sclerotica, varies in the different species of mammalia. It seems to be the greatest in the porcupine, where the cornea extends over half the globe.

"The choroid coat consists, more plainly in the cetacea than in any other mammalia, of two distinct laminæ, of which the internal (*membrana Ruyschiana*) is covered with a dull tapetum. The inner surface of the choroid coat possesses, towards the back of the eye, in several genera of this class, particularly in those carnivorous animals which prey by night, and even in the bisulca, the most brilliant yellow-green and sapphire-blue colors, forming what is called the *tapetum lucidum.* The colored portion of the choroid is only partial, and the rest is covered with a black pigment, as usual. In consequence of this structure, less light will be absorbed, and it must, on the contrary, be reflected from the tapetum against the retina, which lies in front of the membrane of the pigment.

"The retina exhibits in some quadrupeds, viz. the hare and rabbit, very distinct and elegant fibres or striæ of medullary substance, taking for the most part a transverse direction. The remarkable central foramen, which Sömmering discovered in the human retina, has been since demonstrated to exist in the eyes of several quadrumana, where these organs are directed forwards, and have their axes parallel. It is, for instance, very plain in the eye of the common Barbary ape:

the entrance of the optic nerve forms a small yellow circle on the retina, near this a large grey fold appears, with the central foramen in its middle. Man, and such animals as have the two eyes placed with their axes parallel, thereby gain the advantage of seeing objects with both eyes at once, and therefore more acutely. But at the same time they are exposed to this inconvenience, that in a strong light both eyes become dazzled at once; and this happens so much the sooner, because the light falls on the corresponding principal focuses of the eye both at once, the organ not possessing a nictitating membrane. This inconvenience seems to be obviated by the central foramen, since that part which constitutes the principal focus of the eye opens in a dazzling light, so as to form a kind of small pupil, through which the concentrated rays pass, and falling on the choroid, they are absorbed by the black pigment.

"The iris, an organ of very peculiar structure, exhibits in the different genera and species of mammalia more numerous and interesting varieties than any other part of the eye. The colors of its anterior surface, which are peculiar to the different genera, vary in the races and varieties of domestic animals, although less strikingly than in the human structure. These variations are connected with the color of the hair; so that in spotted dogs, rabbits, &c., a mixture of colors will be seen in the iris. The substance of the part varies in thickness in the different genera. In no instance have true muscular fibres been discovered; the examination of the part in the elephant and whale having afforded the same result in this respect as the tender and almost transparent iris of the white rabbit. In the eye of the seal the ciliary vessels are not distributed in the substance of the iris, but lie on its anterior surface, and form a considerable plexus, which is visible without any injection. The pupil in the bisulca, solidungula, cetacea, &c., is transverse; in animals of the cat kind, particularly in a clear light, it is oblong; not to mention various other trivial peculiarities, as the small villous appendix, covered with a black pigment, which is sometimes seen in the middle of the superior margin of the pupil, particularly in the horse.

"The corpus ciliare, or ciliary body, and particularly the folds of its internal surface, with their numerous and elegantly arranged blood-vessels, constitute one of the most wonderful parts of the eye, although its functions, which must undoubtedly be of the highest importance, are hitherto involved in mystery. Its more minute differences in the genera which have been hitherto examined, are too numerous to be recounted, and they could not be understood without delin-

cations. Among other instances, those of the elephant and horse may be mentioned, on account of the remarkable beauty and delicacy of their structure.

"The size of the crystalline lens varies in proportion to that of the vitreous humour, and sometimes very considerably. My friend Dr. Weatherhead found the largest lens, in this point of view, in the eye of the opossum, one of which he presented to the Zoological Society, which is now in their gardens. The whale has the smallest. No mammalia have it so slightly convex on the surface as man. In the cat, hare, the bisulca, the horse, opossum, and seal, it becomes more and more convex, according to the series in which these animals are named. Lastly, in the cetacea, it is nearly spherical. It is curious to observe the regularity with which, in some species, the lens divides into certain segments, commencing from its center, in consequence of being dried, or immersed in acids.

"A lachrymal gland exists in all animals of this class. Several quadrupeds have, indeed, an additional one, besides that which is found in the human subject. Some have no puncta lachrymalia; and the elephant has neither lachrymal bag nor os unguis.

"The nictitating membrane, of which only a rudiment exists in the quadrumana and the human subject, is very large and movable in some quadrupeds. This is the case in animals of the cat kind, in the opossum, the seal, and particularly in the elephant.

"The relative magnitude of the true eyelids varies considerably in animals of this class. The lower, which is very large in elephants, is very small in the horse. In the latter animal, as well as in most quadrupeds, it has no cilia; while in the quadrumana, the elephant, giraffe, and others, both eyelids possess eyelashes.

"*Birds.* The eyes are very large in this class of animals, and consequently the bony orbits are of great magnitude in proportion to the skull. In birds of prey they have a peculiar form, similar to that of the chalice or cup used in the communion service; the cornea, which is very convex, forms the bottom of the cup, and the posterior segment of the sclerotica resembles its cover.

"This peculiar form arises from the curvature and length of the bony plates, which, as in all other birds, occupy the front of the sclerotic coat, lying close together, and overlapping each other. These bony plates form in general a flat, or slightly convex ring, which gives the whole eyeball the above-mentioned form. Dr. Albus observes that the orbit is very imperfect in birds, and thinks that this bony ring may supply the deficiency.

"The distinction between certain parts of the eye, when the membranes have been supposed to be continuous, appears more plainly in some birds than in any other animals. Thus M. Blumenbach found the boundaries of the choroid coat and iris very clearly defined in the horned owl; and those of the margin of the retina, and the posterior border of the ciliary body, very distinct in the toucan.

"A great peculiarity in the eye of birds consists in the marsupium, the use of which has not hitherto been very clearly ascertained. It arises in the back of the eye, proceeding apparently through a slit in the retina; it passes obliquely into the vitreous humour, and terminates in that part, reaching in some species to the capsule of the lens. The figure of its circumference is a truncated quadrangle. Numerous blood-vessels run in the folds of membrane which compose it, and the black pigment by which it is covered suggests an idea that it is chiefly destined for the absorption of the rays of light, when they are too strong or dazzling. Others believe that it serves in this class for the internal changes of the eye; but Crampton has contested this opinion, and described a peculiar circular muscle in the eyeball of the ostrich and several large birds, by which these changes are effected.

"Birds have large lachrymal passages, which terminate in the surface of the palate. In some species, as the common fowl, the turkey, goose, and duck, the lower eyelid, which contains a peculiar small lamina of cartilage, is the most movable; in others, on the contrary, as in the ostrich and parrot, the upper has the most extensive motion. Very few birds have cilia in both eyelids; they are found in the ostrich, the razor-billed blackbird, and in some parrots.

"*Amphibia.* Little is hitherto known concerning the peculiarities in the structure of the eye of this class. In some reptiles and serpents, the common integuments form, instead of eyelids, a kind of firm window, behind which the eyeball has a free motion. In the green turtle the sclerotica has a bony ring at its anterior part, composed, like that of birds, of thin osseous plates. These animals possess very large lachrymal glands, and a very movable membrana nictitans, in which circumstance the frog resembles them.

"*Fishes.* The peculiarities in the eye of fishes, which belong either to the whole class, or to most of the genera and species, consist in the very distinct manner in which the laminæ composing the choroid, the membrana pigmenti, the membrana Jacobi, and the retina appear, and in the existence of two small organs within the eye, which belong exclusively to this class.

"The choroid is continued anteriorly into the iris, and possesses in many species the well-known brilliant gold and silver colors. The

retina is easily separable into two laminæ, of which the external is medullary, and the internal consists of a fibrous texture.

"The two other peculiarities belong exclusively to the eye of fishes, and are common at least to the whole osseous division of these animals. A body, generally resembling in shape a horse-shoe, lies between the membrane of the pigment and the membrana Jacobi or tunica Ruyschiana; some have thought it muscular, and others glandular. The tunica Ruyschiana gives origin to a vascular membrane, resembling in its form a bell. This goes towards the lens, and has therefore some resemblance to the marsupium of birds. No true ciliary body is found, at least in the bony fishes.

"The crystalline lens of most fishes is very large in comparison with the size of the eyeball, and nearly or entirely spherical. The vitreous humour, on the contrary, is small, and the aqueous in many instances is hardly discernible.

"The following may be enumerated as instances of remarkable peculiarities in the eyes of particular genera and species of fishes. The firm transparent laminæ of common integuments, behind which the eyeballs move, as in some amphibia; the articulation of the globe on a stalk of cartilage in the skate and shark; the curtain in the eye of the skate, which can be let down so as to cover the pupil; and the unique structure of the lobitis anableps, where the cornea is divided into two portions, and there is a double pupil with a single lens.

"*Insects.* Two kinds of eyes, very dissimilar in their structure, are found in this class. One sort is small and simple; the others, which are large, seem to consist of an aggregation of smaller eyes; for their general convexity is divided into an immense number of small hexagonal convex surfaces, which may be considered as so many distinct corneæ. The first kind is formed in different numbers in most of the aptera, as also in the larvæ of many winged insects. When these undergo the last or complete metamorphosis, and receive their wings, they gain at the same time the large compound eyes. Several genera of winged insects and aptera have stemmata besides their compound eyes.

"The internal structure has hitherto been investigated only in the large polyedrous eyes. The back of the cornea is covered with a dark pigment. Behind this are numerous white bodies of a hexagonal prismatic shape, and equal in number to that of the facets of the cornea. A second colored membrane covers these, and appears to receive the expansion of the optic nerve. Further investigation is, however, required, in order to show how these eyes enable the insect to see, and to determine the distinctions between two such very different organs.

"*Vermes.* The cuttle-fish only, of this whole class, has been hitherto shown to possess true eyes, the nature of which cannot be disputed. They resemble, on the whole, those of red-blooded animals, particularly fishes; they are at least incomparably more like them than the eyes of any known insects; yet they are distinguished by several extraordinary peculiarities. The front of the eyeball is covered with loose membrane instead of a cornea; the iris is composed of a firm substance, which seems like a continuation of the sclerotic; and a process projects from the upper margin of the pupil, which gives that membrane a semilunar form. The corpus ciliare is very completely formed. In all other vermes the eyes are entirely wanting, or their existence is very doubtful. Whether the black points at the extremities of what are called the horns of the common snail, are organs which really possess the power of vision, is still problematical."

Other important writings of Curtis were as follows:

4. An Essay on the Deaf and Dumb. (London, 1829; 2d ed., 1834; *Ger. Trans.*, Leipsic, 1830.)

5. A Map of the Anatomy of the Eye. (1835.)

6. Observations on the Preservation of the Sight. (1834; *Ger. Trans.*, Lucerne, 1836; *Dutch Trans.*, Amsterdam, 1837.)

7. The Present State of Ophthalmology. (London, 1841.)

Curtis, by favor of the King, was enabled in 1816 to found the first otologic infirmary in London. This was called "The Royal Dispensary for Diseases of the Ear." In this institution Curtis lectured for many years on aural anatomy, physiology and pathology. His death-date the writer has not been able to ascertain.—(T. H. S.)

Curvate. CURVATED. CURVIFORM. Curved.

Curvation. Curving or bending.

Curvature. The rate of deviation of a curve from a straight line, or of a curved surface from a plane.

Curvature hyperopia. When the eyeball exhibits unusual flatness of the dioptric surfaces the resulting ametropia is called hyperopia (or hypermetropia) of curvature.

Curvature myopia. When short-sightedness is the result of excessive curvature of one or more of the dioptric surfaces it is known as myopia of curvature.

Curvature of field. The field of a lens.

Curvature of image. In *optics*, a curvilinear distortion of the image which is due to the principal foci of peripheral rays being nearer to a lens of wide aperture than the principal foci of central rays. Also called *distortion of curvature of the image.* See **Distortion**; also **Aberration.**

Curves, Lissajous's. The fusion of sensation gives the impression of movement in the instrument (known as a toy) called the stroboscope, or "wheel of life." By various methods objects in the position they would have at intervals in the course of movements are shown successively, and the impressions fuse and give the appearance of natural movements. Lissajous's curves, showing the vibrations of tuning-forks, depend on this principle. [Norris and Oliver's *System*, Vol. I, p. 535.]

Curvity. Curvature.

Curvulate. Slightly curved.

Cushion-shaped distortion. See **Distortion.**

Cusol. This is a preparation of copper citrate introduced by von Arlt (*Wien. klin. Wochenschr.*, No. 8, 1910). The solubility of the copper salt is increased by the addition of sodium chloride and sodium borocitrate, to the extent of from 1 to 3 per cent. according to the strength of the solution desired. There are three kinds of cusol preparations, a collyrium, an ointment and a powder.

A $\frac{1}{3}$ per cent. of the collyrium dropped into the eye three times a day does not irritate. It is indicated in recent and not too wide-spread forms of trachoma; also in follicular conjunctivitis and in the milder forms of ophthalmia neonatorum. The second preparation is made from the *unguentum glycerini* of the German Pharmacopeia and 5 to 10 per cent. copper citrate, with the same amount of sodium salts as are prescribed for the collyrium. This preparation is to be used in exactly the same way as cuprocitrol (q. v.). The powder is composed of the sodium salts and 20 per cent. of copper citrate mixed with sterilized corn starch. It is dusted into the eye just as calomel is used, and is employed in the most serious forms of trachoma. Its immediate action is that of an irritant. See **Cusylol.**

Cusp. In *optics,* the vertex of a *caustic* (q. v.).

Cusson, Pierre. This naturalist and ophthalmologist was born at Montpellier, in 1727. He studied at the College of the Jesuits and entered their order, but withdrew five years later, and then, at the age of 23, began to study medicine. His medical degree he received in 1753. He was commissioned by the French government, in 1754, to study in Spain the flora of that country. While in Spain, he became extremely obese, and so resigned his botanical commission and returned to Languedoc, where he practised for five years at Sauve. Removing to Montpellier, he taught anatomy and botany in that city for some time. In 1778 he was made professor of mathematics at the Academy of Montpellier. He died in 1783.

He was a bitter opponent of Daviel's new treatment for cataract by extraction. In 1778 he published a "mémoire," entitled "Remarques sur la Cataracte," in which he promulgated his own peculiar views regarding "maturité de consomption" and "maturité d'exfoliation," and in which he strongly favored depression as opposed to extraction. —(T. H. S.)

Cusylol. Cupri citras solubilis (Arlt). According to a circular of Lehn and Fink, this is a new, non-irritating preparation of copper, soluble in water, for the treatment of trachoma and of gonorrheal diseases of the eye and of the uro-genital system. Cusylol is a double salt of copper citrate and sodium boro-citrate. It forms a blue powder, dissolving readily in water to a dark-blue solution. It is insoluble in alcohol, ether, etc. Cusylol contains, in the dry state, about 14.9 per cent. of copper. Cupri citras solubilis "Arlt" is far more soluble in water than simple cupri citras (the latter requires 9,143 parts of water, the former about 1 part of water for its solution). This property alone would lead one to presume an increased therapeutic action, and all experience has so far confirmed this presumption. Cusylol and its preparations have an excellent bactericidal action, though they have no caustic effects.

The treatment of the diseases mentioned below with cusylol preparations has the following advantages over other methods of treatment: The preparations, with the exception of the powder, may be readily applied by the patients themselves several (3 to 6) times a day if necessary. Small doses (1 to 5 per cent.) produce no pain, large doses only slight pain. Even largest doses have no caustic action on the mucous membrane. Hence there is no scar-formation or contraction as the results hitherto obtained have shown, and the process of healing is far more rapid, for with suitable dosage and careful supervision by the doctor healing requires scarcely half as long as in the case of other therapeutic methods.

Cusylol is at present used in three different forms:

Cusylol solutions containing ⅓ to 5 per cent. of cusylol for diseases of the eyes.

Indications: ⅓ to 1 per cent. solutions are very well tolerated by the subjects of old cicatrized trachoma. 1 to 2 per cent. are to be used in new and old forms of trachoma when there is not too much discharge; after mechanical treatment and also in addition to cusylol ointment (the solution to be applied morning and mid-day, the ointment as late as possible at night); the 2 to 5 per cent. solutions in fol-

licular conjunctivitis, the former in mild cases; the 5 per cent. in severe cases of ophthalmia neonatorum (whether gonococci be found or not).

The communications of Sattler and von Arlt show the 5 per cent. solutions to be quite free from danger as a prophylactic in place of the silver salts for the Crédé treatment of new-born infants. In infective and suspicious conjunctival catarrh 2 to 5 per cent. solutions of cusylol are of good service.

Ointments containing pure cusylol in concentrated form have a slight irritant action. It is best, therefore, to prepare cusylol ointment from special powdered cusylol suitable for the purpose. It has the following composition: Cupri citras amorph. "Agfa," 100; Cusylol, 10; Sodii chlorid., 16; Sodii boro-citras. "Agfa," 8.

5 to 10 per cent. of this powder are worked up with ungt. glycerini, to make cusylol ointment.

Cusylol ointments are indicated in recent and old trachoma with slight discharge, and in follicular catarrh.

Cusylol-powder is intended for use in the most severe forms of trachoma with copious discharge and pannus crassus. Hence it is principally useful for recent acute cases in which fairly strong silver nitrate solutions are used as a rule. The application causes little pain; the result, as described particularly by Purtscher, is surprisingly good. It has the following composition: Cupri citras amorph. "Agfa," 100; Sodii boro-citras "Agfa," 5; Sodii chlorid., 15.

Twenty parts of this powder are mixed with eighty parts of a sterile, indifferent powder, preferably flour or starch, for the preparation of cusylol dusting powder.

Motolese (*Ann. di Ottal.*, Vol. 41, p. 315, 1912) describes his physical, bacteriological and clinical experiments and observations with regard to the drug, and states the following conclusions: (1) In contrast with sulphate of copper, which is powerfully astringent, cusylol is completely lacking in such action, and is therefore in this respect unquestionably superior to the older copper salt; (2) cusylol cannot be numbered among the bactericides of the first order, although this fact is offset by the ability to employ strong solutions and several doses daily; (3) in ophthalmia neonatorum the drug is useless; (4) in trachoma it offers great advantages at all times except in the acute stage. See **Cusol.**

Cutaneous excitation test. SKIN REFLEX. CUTANEOUS STIMULATION TEST. As Parinaud (*System of Diseases of the Eye,* Vol. 4, p. 733) points out, Morawcsik and Freund have discovered a curious peculi-

arity that cutaneous excitations modify the extent of the visual field. The writer has been able to show that puncturing the skin, on no matter what part of the body, increases the extent of the visual field until in certain cases it renders it normal. Excitation of one-half of the body may modify the visual field of both eyes. When the amblyopia is unilateral, cutaneous excitation produces sometimes a transfer, the narrowing of the field disappearing in the affected eye and developing in the healthy eye. Cutaneous excitation is without effect in the presence of cutaneous anesthesia.

Le Dantec (*Société de biologie,* Paris, July 8, 1893) states that cutaneous excitation in hysterical patients produces subjective sensations of color. In one patient, the eyes being previously covered, pinching the skin on the border of an anesthetic area gave a sensation of green; excitation by heat caused a sensation of red.

Cutaneous stimulation also produces quite readily dilatation of the pupil.

Cutaneous geromorphism. A cutaneous disease that has been known to affect the upper lid to the extent of producing ptosis. It is characterized by extreme relaxation and flaccidity of the integument in divers parts of the body, which assumes a bagginess that gives it, even in young subjects, precisely the appearance of the skin of the aged. The condition may become general over the entire body.

Cutaneous horns of lid. See **Cornu cutaneum.**

Cutaneous system, Ocular relations of the. See **Dermatology in its relations to ophthalmic diseases.**

Cuticular conjunctiva. (L.) Xerosis of the conjunctiva.

Cutter, George Rogers. (1840-1891.) A distinguished ophthalmologist and linguist of New York City. He was house surgeon of the New York Eye and Ear Infirmary, 1867-68; assistant surgeon, 1868-75; and surgeon from 1875 to his death in 1891. Cutter published an English translation of Frey's *Histologie* (1876) and "A Dictionary of the German Terms Used in Medicine" (1879). He became a member of the American Ophthalmological Society in 1887. Dr. Cutter was about five feet nine inches high; slim, well-shaped, erect; with an oval face, blue eyes, an aquiline nose, and, as a rule, a small mustache. He was a well-read man, both in general and medical literature, spoke several languages fluently, did much translating for medical journals, and wrote on a wide variety of subjects.

He was, too, a man "of infinite jest"—a fact which made him many enemies as well as friends, for he was often misunderstood. He

was not a religious man, and was very outspoken when expressing his views on religious subjects.—(T. H. S.)

Cutting the eyeball. Cutting of sections. See **Microscopical examination of the eye.**

Cuvette à tampons. (F.) Dish or basin for holding pledgets of cotton or gauze.

Cyanammonium. In considering the products of the destructive distillation of organic matter involved in the smoking of tobacco, it must not be forgotten that other agents besides nicotin and nicotianin may account for the deleterious effects upon the eye. Among these is probably this agent.

Cyan-blue. A greenish blue.

Cyanean. Cyaneous. Of a blue or azure color; cerulean.

Cyanide of mercury. See **Mercuric cyanide.** $Hg(CN)_2$. This important mercurial salt occurs as white, odorless, prismatic crystals with a bitter, metallic taste; soluble in both water and alcohol. Very poisonous. It is permanent in air if the light be excluded. It is used subconjunctivally; otherwise in 1:20,000 to 5,000 solutions as a substitute for corrosive sublimate, than which it is less irritative.

H. W. Woodruff strongly advises subconjunctival injections of solution of cyanide of mercury in purulent infections of the eyeball, such as ulcers of the cornea, hypopyon keratitis and infections following cataract extraction. He has become convinced that this method of treatment, if used in the first twenty-four hours, will check such a process. In the post-operative infection known as ring abscess, he has proven certainly to himself and to others that this method, if used early, even when the ring of exudate is distinctly seen, will check the purulent process.

D. C. Bryant uses the following formula in nearly all forms of conjunctivitis: Acid, boric, ʒi; Hydrarg. cyanid., gr. ss; Aquæ dest., fl. ʒvi.

He very much prefers the cyanide of mercury to the bichloride as long experience with it has convinced him that it is a better germicide and less irritating.

Burton Haseltine has used subconjunctival injections of oxycyanate of mercury in three cases of sympathetic or transferred ophthalmitis with better results than could have been reasonably expected from other forms of treatment. From three to five drops of a 1 to 2000 solution were injected into the sympathizing eye every two, three or four days, according to the severity of the symptoms.

H. J. Hornbogen prefers the following formula in phlyctenular and other forms of corneal ulcers. Dionin, gr. v; Cocain. mur., gr. iii; Sol. hydrarg. cyanid. (1-4000), fl. ℥i.

In 1901 the editor drew attention to its employment in conjunctival catarrh. After cleansing the mucous membrane it is to be touched lightly with a cotton swab soaked in the following solution: Hydrarg. cyanid, 1.00 (gr. xv); Aquæ dest., 100.00 (fl. ℥iijss).

This should immediately be washed off with distilled water. (Wood's *System of Ophthalmic Therapeutics*, p. 503.)

Cyanide of potassium. KCN. This exceedingly poisonous salt occurs as white, amorphous, deliquescent masses, with an odor of hydrocyanic acid. It is very soluble in water. One per cent. solutions have been used to remove silver stains from the conjunctiva. The solution should be dropped into the conjunctival sac and its action carefully watched.

Cases of amblyopia due to the ingestion of potassic cyanide are exceedingly rare; disturbances of the normal pupillary reflexes being about the only observations of this kind on record.

Cyankalium. (G.) Potassium cyanide.

Cyanochroic. Cyanochrous. Of a bluish color.

Cyanometry. The measurement of the blueness of the sky.

Cyanopia. Kyanopia. Cyanopsia. Blue-vision. A perverted state of the visual powers, during which all objects appear blue. This anomaly has been observed in connection with optic nerve and retinal atrophy; as an epileptic aura; after cataract operation; in influenza; after an apoplectic seizure; in connection with macropsia and metamorphopsia, as well as numerous other nervous symptoms; in arteriosclerosis of the retinal vessels; and following an excess in alcoholics. Blue-vision has also been reported by de Kleijn in tumor of the hypophysis.—(C. P. S.)

Kyanopia has been observed by Enslin (*Zeit. f. Augenheilk.*, 1906, p. 136) in numerous cases immediately after extraction of cataract, mostly nuclear cataracts. It gradually decreased and disappeared after one or two weeks, and was never seen later than one month after the operation. Enslin explains the phenomenon by the theory of contrast. The human crystalline lens has, from childhood on, a yellowish hue, which increases with advancing age and is more pronounced in cataract, particularly nuclear cataract. In such eyes yellow rays have been acting on the retina for years, while the blue rays were absorbed by the yellow lens. After removal of cataract the contrasting blue rays suddenly gain entrance to the retina and arouse

intense blue vision. This very rarely occurs if much cortical matter remains in the eye, which at first admits little light, gradually more by being absorbed, thus preventing the action of contrast. The few cases of kyanopia published are of cerebral etiology and have no bearing on kyanopia after cataract extraction.

See, also, **Blue-green vision** (Vol. II, p. 1236 of this *Encyclopedia*) as well as **Chromatopsias** (Vol. III, p. 2198 and p. 2202).

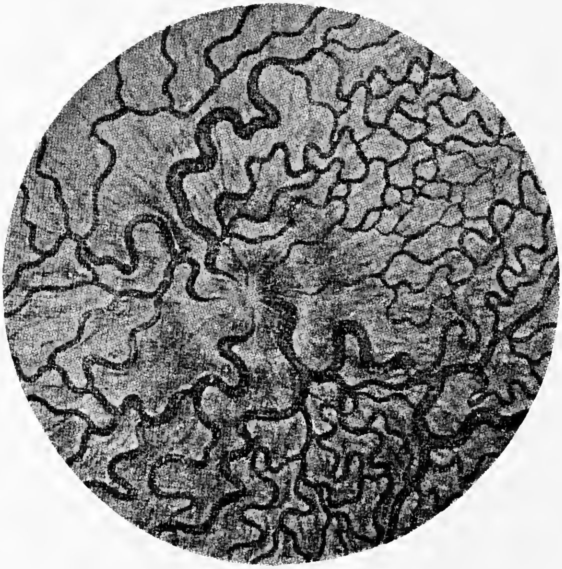
Cyanosis of the eye. This term is generally applied to both the external and internal appearances of the eyeball in patients with general cyanosis from congenital disease of the heart. However, a cyanotic condition may be due to other causes such as botulism, quinin poisoning, cholera, etc. Whatever the cause of the cyanosis the fundal vessels, especially the veins, are dilated and tortuous. The blood in them is darker than normal, so that the arteries resemble ordinary retinal veins. Large macular hemorrhages may be present; similar bleedings are observed near the disk and at the periphery. Vision is often normal, although it is generally much affected. In cyanotic polycythemia the retinal veins are much distended and filled with very dark blood, while the arteries are not much influenced by the disease. The ophthalmoscopic appearances in this condition were first described by H. Knapp. Since his time a number of cases have been depicted; in America, by H. H. Tyson and Campbell Posey especially, W. R. Parker and G. Slocum (*Ann. of Ophth.*, Vol. 20, p. 73, 1911) have also described two cases of chronic cyanosis with polycythemia.

Cyanosis retinæ. Tyson (Abstract in the *Ophthalmic Year-Book*, from the *Arch. of Ophth.*, Sept., 1908) details a case of cyanosis retinæ occurring in a patient aged 12 years, in which a diagnosis of congenital, patent foramen ovale with pulmonary stenosis was made.

The clinical history and the anatomic pathology of a case of bilateral amaurosis which developed suddenly in a patient with congenital cyanosis is given by Baqnis (Græfe's *Arch. f. Ophth.*, Vol. 68, 2, 1908). The patient was a male, 11 years of age, who complained of severe dyspnea and of a cloud before his eyes. Vision in O.D.=L.P.; O.S., hand movements, 30 cm. The entire skin, from the scalp to the extremities, was of a deep violet color. The visible mucous membranes were also involved. There were no hemorrhages. The superficial veins were everywhere visible, more through the number of their branches than through their dilatation, as the larger trunks gave the impression of being empty and flat. The heart was enlarged and there was a presystolic murmur over the apex. The radial pulse was 120. The liver and spleen were enlarged. The

blood was brown from hyperglobulin. Red cells 8,500,000; white 23,000; hemoglobin (Fleisch) 112 per cent.

The skin of the lids was blue-brown, which in the tarsal conjunctiva and the retrotarsal fold reached the color of tartar. The bulbar conjunctiva was cyanotic and over it ran coarse, almost black veins. There was exophthalmus due in part to widening of the fissure and in part to engorgement of the retrobulbar orbital tissues. The pupils were partially dilated and reacted sluggishly to light. The irides



Eye Ground in Baquis' Case of Cyanosis of the Retina.

were blue, but that of the right eye was less brilliant and had a somewhat yellowish tint, probably the result of irritation, as there was in this eye slight pericorneal injection. In the right eye no ophthalmoscopic examination was possible, as on the temporal side only a faint-reddish glare could be obtained, and everywhere else but a brown reflex. In the left eye all of the arteries except the superior and inferior branch, for a short distance, had completely disappeared. The veins had enormously developed and coursed with extreme tortuosity as large black bands. In the entire retina every venous twig was visible because of its distention. In their course was found knots and pouch-like ectasias. Round, striated and splotched hemorrhages were everywhere visible. The changes were active and the

white, scattered retinal spots of atrophy showed that they had long been in progress. The papilla had lost its normal color and its edges were invisible. Its position was indicated by the prominence of the vascular trunks. The macular region was beset with hemorrhages. The surface of the retina was as if covered by a fine grey veil, probably the result of connective tissue proliferation. The retina was seen with a +7 D.

Ten days after this examination the iris tissue of the right eye underwent a sudden change in color, from blue to chestnut-brown, accompanied by signs of iritis, but the pupil dilated fully without leaving pigment on the lens capsule. Five days later similar changes occurred in the left eye. The binocular loup showed enormous distention of the blood vessels of the iris. The swollen and tortuous vessels formed a pupillary and a ciliary network, which projected from the surface of the iris like a blood sponge. The color of the vessels (which were apparently veins) was a deep brown.

In patients suffering from congenital general cyanosis there is observed at times this ocular complication known as cyanosis retinæ. This term, which seems sufficient for cases of slight or moderate intensity, is incomplete for severe cases, which are better described, Baquis believes, by the term cyanosis oculi.

In simple cyanosis retinæ, which is compatible with normal visual function, there is observed, ophthalmoscopically, besides the brown coloration of the vessels, a distention of both the veins and the arteries. The explanation of this phenomenon is that in mild general cyanosis the blood does not contain sufficient carbonic acid gas to strongly stimulate the vasomotor constriction centre, and this leads through moderate stimulation to constriction of the visceral vessels, thereby forcing the blood into other organs and there among the retina, causing dilatation of its vessels.

In severe cases of general cyanosis the ocular fundus picture completely changes. The blood, overcharged with acid, produces marked stimulation of the medullary centres, and produces much more intense and more general vasomotor constriction, including the retinal arteries. In the ophthalmoscopic examination one sees, in fact, the veins greatly distended, and the arteries, on the contrary, unusually constricted, indeed in some places they have apparently disappeared. The constriction of the arteries leads to an intense venous stasis, and upon this follows diffuse apoplexies, venous and arterial thromboses, and also diffuse intraocular hemorrhages, which finally call attention to the eye-grounds. The visual function is, in these cases, rapidly and completely destroyed from the beginning of the attack.

The iris is, because of the arterial spasm, the seat of a decided venous stasis and, because it is changed into an actual blood sponge, alters its color, so that if it were originally blue it becomes a chestnut brown.

The iridocorneal angle is the seat of a slow inflammatory process which leads to its obliteration and to a glaucomatous condition, which may reach such a high grade that it causes rupture and subsequent atrophy of the globe. This union of intense and incurable changes of the entire eye produces a clinical picture which may well be termed cyanosis oculi, the one cause of which is an intense arterial spasm excited by carbonic acid stimulation of the medullary centre. Such vessel changes have the heretofore unknown characteristic that they produce a constriction and also obliteration of the lumen of the vessels, not through the usual process of endarteritis, but by a primary contraction of the muscle coat, which later, as the result of a hypertrophy of its elements, is compensated for. A proliferation of the intima can be observed at most in the final stadium of the disease after thromboses and hemorrhages have occurred.

T. B. Holloway (*New York Med. Jour.*, Jan. 13, 1912) adds one case to the few in which the eyes have been examined in cases of congenital heart disease. The patient was a boy, 3 years old, and was under observation for five months, during which time no decided change took place in the fundus. There was a distinct enlargement of the veins of the lids. No definite degree of exophthalmos could be said to be present, but the eyes seemed to be prominent, probably dependent upon the widening of the palpebral fissure as the result of his dyspnea, and possibly assisted by the engorgement of the orbital veins. The ocular conjunctival vessels were slightly distended and of a chocolate color. The palpebral conjunctiva, especially toward the margins of the lids, was purplish in color. The bluish tint of the sclera was exaggerated, but no pronounced discoloration of this structure was present. In each eye the media were clear and the fundus was darker than one would expect to find in a blond, but hardly as dark as one sees in a negro. The discs were oval, dusky red in color, and the edges, while blurred, were not completely obscured. Many fine vessels, not ordinarily observed, could be noted on the disc. The veins were enormously distended, extremely tortuous, and almost black in color, and all of the larger branches presented a pronounced reflex stripe. The arteries were also somewhat darker in color, larger in caliber and more tortuous than normal, but here the changes were

very much less marked than in the veins. No free hemorrhages or exudates were observed.

Cyanotic polycythemia. See **Cyanosis of the eye.**

Cyanotype. A photograph made by the "ferro-prussiate" process.

Cyanuret of mercury. See **Mercuric cyanide.**

Cyclencephalus. A monster-fetus with the eyes blended into one.

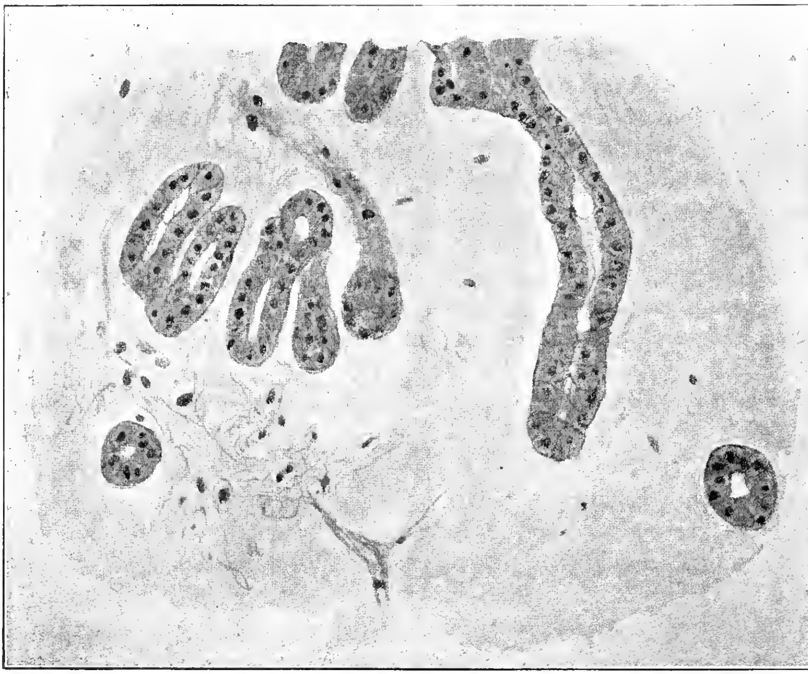
Cyclical albuminuria. FUNCTIONAL ALBUMINURIA. TEMPORARY ALBUMINURIA. PHYSIOLOGICAL ALBUMINURIA. It has been known that albumen is occasionally found in the urine of apparently healthy persons. Sometimes ocular lesions accompany this condition, but it is probable that they are rare. Eales (*Birmingham Med. Review,* Jan., 1880, p. 46) and Ostwalt (*Wien. klin. Rundschau,* 1897, No. 41) have both reported cases of this sort. The former examined fourteen males between the ages of eleven and twenty-eight, suffering from what was believed to be temporary or functional albuminuria, and found retinal changes in five,—that is, in rather more than thirty-three per cent. These changes he described as similar in character to those met with in cases of chronic nephritis, consisting of white degenerative spots and patches. No mention is made of hemorrhage in the retina. Ostwalt has reported in considerable detail two cases of cyclical albuminuria in which ocular lesions were present; one in a female thirty-two years of age, the other in a male aged sixteen. In the former, recurrent hemorrhages from the retinal vessels of the right eye occurred, followed by the formation of a thin vascular connective tissue, attributed to the organization of a blood-clot, in one part of the fundus oculi, and of limited detachment of the retina in the same region. In the latter, a localized choroido-retinitis of the left eye was found, with recent inflammatory exudation. Twelve days later paralysis of the left facial nerve occurred. Recovery from the retinal and paralytic lesions ensued.—(Abstract from Norris and Oliver's *System,* Vol. 4, p. 658.) See, also, Vol. 1, p. 207 of this *Encyclopedia.*

Cyclicotomy. INTRAOCULAR MYOTOMY. An incision into, or division of, the ciliary body, done for the purpose of relieving increased tension; devised by Hancock for the cure of glaucoma, and called by him intraocular myotomy.

Cyclite. (F.) Cyclitis.

Cyclitic membrane. This organized deposit is occasionally seen in eyes removed after injury. It stretches across the eyeball behind the lens and is usually connected with the hyaloid membrane. Parsons remarks that in this condition the lens is often completely embedded in dense fibrous tissue, which occludes the pupil and leads to total

posterior synechia. The lens capsule remains intact, though it is often wavy and folded owing to the degenerative changes which take place in the lens and lead to shrinking. The lens under such circumstances may become calcareous, but never bony (as long as the



Tubules in Cyclitic Membrane. x 300. (After Treacher Collins.)

capsule is intact) because the latter apparently forms a barrier impassible to osteoblasts.

Cyclitis. CYCLITIS IN GENERAL. Inflammation of the ciliary body. This disease may be divided into *serous, plastic, purulent* and other forms, each of which will be considered under appropriate headings.

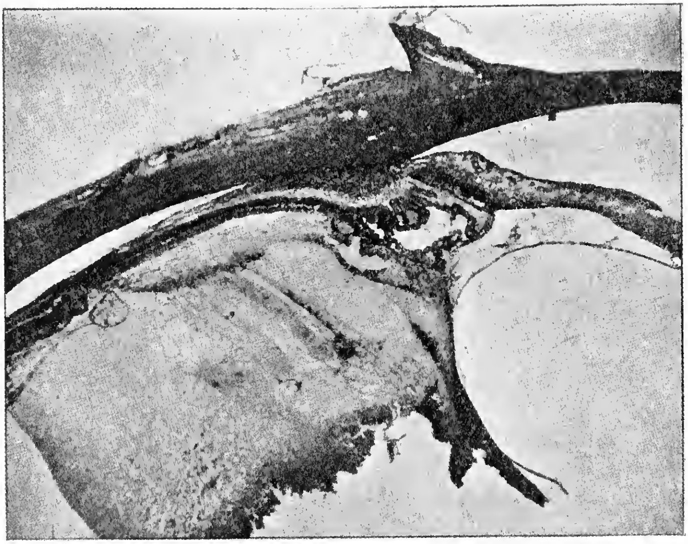
The ciliary body is so closely related to the choroid, iris and other neighboring structures that it is often difficult to speak of cyclitis apart from inflammatory involvement of other organs; hence the terms *iridocyclitis*, *choriocyclitis*, etc. De Schweinitz (*Diseases of the Eye*, p. 419) gives the following symptoms which he believes in general lead to the *diagnosis* of the majority of the forms of cyclitis: Edema of the lid, injection of the circumcorneal or ciliary zone, neuralgic pain, and tenderness on pressure in this region; change in the aqueous humor, which grows turbid; precipitates of exudation in gray-

ish-brown points upon the posterior layer of the cornea, and at times hypopyon; exudation in the posterior chamber, attaching the under surface of the iris to the lens-capsule in a complete posterior synechia, the retraction thus produced causing a deepening of the anterior chamber; exudation into the vitreous causing opacities, especially in its anterior layers; and alterations in the tension of the globe, which may be increased or decreased. The general *symptoms* of pain, photophobia, lachrymation, etc., are present in the acute types of the disease, and vision is seriously impaired according to the amount of the exudation in the pupillary space and vitreous.

According to Parsons (*Pathology of the Eye*, Vol. I, p. 336) who gives an admirable review of the *pathology* of cyclitis in general, the first anatomical sign of *acute cyclitis* is intense hyperemia, with dilatation of the vessels, which are packed with red corpuscles and surrounded by leucocytes, these being also more numerous inside the vessels. The connective tissue is most affected, the ciliary muscle escaping to a large extent. The former is edematous and densely crowded with mono- and polymorphonuclear leucocytes, which obscure the normal structures. The mast-cells, which are normally present in small numbers, are much multiplied. Even in very early stages, *e. g.* during the first hours after an injury, the leucocytes are not confined to the ciliary body itself, but penetrate between the retinal epithelial cells and escape into the vitreous, the posterior chamber, etc., and are carried by the lymph-stream into the anterior chamber, where they may accumulate and form an hypopyon. The iris is invariably inflamed in greater or less degree. The lymph secreted by the inflamed ciliary processes contains an excess of proteids, and is readily coagulable. The coagulum varies greatly in the amount of fibrin present. This may be almost absent, so that the hypopyon is fluid; in this case the cells may break up and pass away through the normal channels of excretion at the angle of the anterior chamber, though they are frequently reinforced and a fresh hypopyon forms. In the more acute and more plastic forms of inflammation the exudate in the vitreous, amongst the fibres of the zonule, in the posterior chamber, pupillary area, and anterior chamber, may be composed of a dense network of fibrin containing leucocytes in its meshes. The more solid hypopyon present under these conditions is less readily disposed of, and may subsequently organize. Still more resistant are the coagula behind the iris, and it is around the lens in this situation that the first traces of fibrous organizations appear, even as early as the eighth day (Buchanan).

Schirmer (Graefe's *Archiv. f. Ophthalm.*, Vol. 74, p. 224, 1910) says

that it was due to our coarse methods of measuring tension that we did not sooner learn that hypotonus was a constant symptom, even at an early stage, of acute and also of chronic cyclitis. He has used in his tests the Livschitz modifications of the Fick tonometer. He records as examples fifteen observed cases. Cyclitis serosa furnishes an apparent but not real exception, as it is complicated by diminished loss of fluids. His tests were made on animals into whose vitreous (technic given) a drop of mercury had been injected. He



Cyclitis. x 9. (Parsons.)
Cyclitis of fourteen days' duration. Exudate in the vitreous, lying upon the ciliary body, retina and lens capsule.

finds that in almost all intra-ocular inflammations the aqueous humor is produced in abnormally small quantities and contains an abnormally large amount of albumin, pointing to a severe disturbance of function in the ciliary body. The direct cause he considers to be simultaneous lessening of vascular pressure and dilatation of the vessels.

In the *chronic forms* of cyclitis or iridocyclitis the principal sign of serous cyclitis is the well-known deposits upon Descemet's membrane of round dots, which first gave to this disease the name *keratitis punctata*. According to Parsons (*Pathology of the Eye*, Vol. 1, p. 349) they were first accurately described by Wardrop (1808), and attributed by him to inflammation of Descemet's membrane—*Descemetitis, hydromeningitis, aquocapsulitis, keratitis punctata.* Ruete

(1845) and Stellwag v. Carion first pointed out that inflammation of a structureless membrane like Descemet's cannot occur, and further that this membrane does not extend over the iris and has nothing to do with the secretion of aqueous. Arlt (1853) regarded the deposits as a product of iritis, and von Graefe (1856) showed ophthalmoscopically the frequent participation of the choroid in the inflammation in these cases. Schweigger (1873) and Iwanoff (1876) give the first description of the miscroscopic appearances, which they consider due to the proliferation of the endothelium of Descemet's membrane. De Wecker (1876) describes a fibrous exudate as occurring first at the spots, followed later by proliferation of the endothelial cells. Knies (1880) found small groups of round-cells, under which the endothelium was intact and unchanged; in later stages, and in the case of larger deposits, the endothelium had disappeared, and the round-cells showed degenerative changes, their contours being indistinct. He observed similar exudates upon the surface of the ciliary body, but doubted their ability to traverse the zonule of Zinn. He therefore attributed those on the back of the cornea to iritis; we now know that such exudates can be readily carried forward by the lymph-stream, passing between the fibres of the zonule, which does not form an inpenetrable membrane. Fuchs (1884) first brought forward incontrovertible anatomical evidence that the deposits are a sign of chronic cyclitis, and that they are chiefly derived from the ciliary body. He found them to consist of aggregations of leucocytes, many of which contained pigment granules, showing their origin from the uveal tract. The cells usually have large nuclei and a small amount of cytoplasm, so arranged as to resemble a signet-ring. The precipitates lie upon the endothelium of Descemet's membrane, which is at first quite normal; later, and under larger deposits, the endothelium degenerates and disappears. The endothelium is therefore not in most cases the active cause of the deposits. In late stages the cells undergo fatty degeneration and become absorbed, leaving the pigment granules behind. These then appear as fine pigmented spots. Schweigger (1885) described proliferation of the endothelium around the deposits; he considered them to consist of detritus and degenerated cells deposited on the back of the cornea, and easily washed off, *e. g.* by the escape of aqueous on puncturing the anterior chamber. Snellen, Jr. (1894) found groups of bacteria in the deposits; this observation has not been confirmed for ordinary keratitis punctata, and must be of rare occurrence. Ridley (1895) confirms the results of earlier observers, including the normal condition of the endothelium in the early stages. That proliferation of the endothelium may, however,

occur has been shown by Uhthoff and Axenfeld (1896). They obtained warty endothelial growths after inoculation of pneumococci into the anterior chamber of rabbits. Groenouw (1900) found pigment granules partly within and partly outside the cells; he also found giant-cells, or bodies resembling them, and a network of fibrin between the cells and often lying upon the intact endothelium, which he thinks plays a purely passive part. Whilst the leucocytes which form these precipitates are commonly derived mainly from the ciliary body, Bass (1903) has adduced good evidence that they may come from the iris alone. In his case there was total posterior synechia, and a fresh attack of inflammation was followed by new deposits; these could not have passed through the iris, but must have been derived from it. The pigment was derived by Leber (1879) from degenerated red corpuscles; in the majority of cases it is undoubtedly uveal (Knies, Fuchs, Groenouw). Probably it may originate from either source. The larger deposits of long standing, which are known clinically as "mutton-fat keratitis punctata," show a hyaline degeneration of the cells. These are swollen, and run together more or less; the nuclei stain badly or not at all, though their outlines can often be made out dimly. The masses stain with cytoplasmic stains, but diffusely with nuclear stains. There can be little doubt that the cells are deposited centrifugally upon the back of the cornea, and that the movements of the eyes are a factor in determining their arrangement (Arlt). The spots are occasionally seen upon the lens capsule; it would be impossible for them to be derived here from endothelium, but the absence of endothelium may account for the infrequency of their occurrence in this situation. It is probable that in the conditions under which they occur the endothelium of Descemet's membrane is irritated and becomes sticky, so that the leucocytes readily adhere to it. Deposits resembling keratitis punctata may arise from other causes, usually malignant growths. Von Michel describes a round-celled sarcoma of the ciliary body in which nodules of tumor-cells were found upon the back of the cornea, the endothelium being normal. Similar deposits of glioma-cells may occur. Whilst the aqueous in serous cyclitis is richer in proteids than the normal fluid, yet there is less tendency to coagulation than in acute cyclitis. The inflammation is more of the catarrhal than the plastic type, and the exudate is relatively poor in fibrin. Such considerations have led Treacher Collins to regard the condition as a catarrh of the glands of the ciliary body. The anatomical changes which occur in the ciliary body differ chiefly in degree from those found in acute cyclitis. The ciliary processes are moderately swollen, and may touch the back

of the iris (Fuchs). The tissues are infiltrated with leucocytes which are chiefly arranged around the blood-vessels, but may also occur in nodular masses, especially in the posterior part of the ciliary body. These consist mostly of mono-nuclear lymphocytes, and are found especially between the ciliary muscle and the pigment epithelium. The latter may be little altered, the exuded cells passing between the epithelial cells into the vitreous. Here they form masses on the inner surface of the ciliary body, especially in the depressions between the processes and folds; others lie free on the surface, and in every respect resemble the deposits on the back of the cornea. Groenouw found partial atrophy of the epithelium of the pars plana. The vitreous contained round-cells and fibrillæ, especially in the anterior part, and to some extent in front of the optic disc. The iris was infiltrated and also the deeper layers of the peripheral part of the cornea. Groenouw considers iritis as secondary to the cyclitis. He found the choroid, retina, and optic nerve healthy, but other observers have found them affected (Knies, Fuchs).

Fuchs (*Text-Book of Ophthalmology,* p. 389) believes that it is possible to make a *diagnosis between cyclitis and irido-cyclitis* only in those cases in which, in addition to the symptoms of iritis, positive evidence of involvement of the ciliary body is at hand. A cyclitis apart from or in conjunction with an iritis is probably present when the inflammatory symptoms reach a considerable pitch, and especially if edema of the upper lid is associated with them—a thing which does not occur in simple iritis; when the eyeball in the ciliary region is painful to the touch; when from the presence of a pupillary membrane, of many posterior synechiæ, or of an annular or a total adhesion of the iris to the lens capsule we can infer that the exudation is specially great; when the disturbance of vision is more considerable than one would expect from the opacities within the confines of the anterior chamber. We are then justified in inferring the existence of opacities in the vitreous causing diminution of vision; and if the tension is altered—either elevated or lowered.

The *prognosis* and *termination* of cyclitis will largely depend upon its causes, which will be discussed under the various forms of the disease. It may be said here that the etiology of cyclitis in general is systemic—that is, due to syphilis, rheumatism, gonorrhea, tubercle, scrofula, acute infectious diseases and disorders of metabolism. It is, however, often local; in which case it is most commonly due to penetrating wounds of the eyeball and to sympathetic ophthalmitis.

Whatever the cause of the cyclitis the acute inflammatory forms generally run a comparatively short course; nevertheless they last four or five weeks before the inflammation subsides. On the other hand, chronic cases may continue for months or years. Relapses, posterior synechiæ, pupillary membrane (occlusion of the pupil), secondary cataract and exudates behind the iris are common sequels of this disease. Fuchs gives a well-defined picture of these inflammatory results and describes, in particular, the atrophy of the iris that follows some cases of chronic cyclitis. This is, he says, characterized by a bleached-out, gray, or grayish-brown aspect of the iris (resembling gray felt or blotting paper); the delicate markings of the anterior surface have disappeared, and in their stead dilated vessels can often be recognized as reddish blotches upon the surface of the iris. The pupillary margin is thinned down, often looking as if it had been frayed out; the reaction of the iris is diminished or altogether lost. The great friability of the atrophic iris often renders the correct performance of iridectomy impossible. The exudates which lie behind the lens in the vitreous cause by their contraction a diminution of volume of the vitreous; the eyeball then becomes softer. The shrinking of the vitreous results in detachment of the retina from the choroid; in part also this detachment is produced by direct traction, since the hull of cyclitic membranes as it shrinks attaches itself to the inner surface of the retina and draws it out of its bed. In consequence of the detachment of the retina, complete blindness ensues. This state of things, consisting of diminished tension of the eyeball, with decrease in its size and with complete blindness, is known as atrophy of the eyeball. An atrophic eyeball presents the following picture: The whole eye is smaller and of slightly quadrangular shape. This is because the four recti muscles, stretching across the equator of the eyeball, press the sclera in somewhat at this spot, and hence produce flattening at the four sides. With the higher degrees of atrophy quite deep furrows are formed, so that the eyeball has the form of a bale of goods grooved by the cord with which it is tied. The cornea is smaller, often opaque and flattened; at other times, again, transparent, but abnormally protuberant or wrinkled. The atrophic iris is either pressed quite against the posterior surface of the cornea, or an anterior chamber still exists. In the latter case, we find the chamber bounded behind by a firm diaphragm in which the iris, which is imbedded in the hull of exudate, is often but indistinctly recognizable. If the pupil is still distinguishable, a membrane and the opaque lens are found in it.

The eye is softer, and is often sensitive to the touch. In the latter stages markedly hard spots (ossified exudates) may sometimes be felt through the sclera. Atrophy develops gradually during a course of months and years. The inflammation and the pain, which have been present for a long time, disappear when the atrophy is complete. But even then secondary attacks of pain occur, especially if the eye harbors a foreign body, or if ossification of the exudate takes place.

The *treatment* of cyclitis depends upon combating the local symptoms and on removing the causes that set it up. When it is not possible to demonstrate the latter the conduct of the case resolves itself into relieving the symptoms. Although this subject will again be referred to under each form of the disease, yet it may be said here that, as in iritis, atropin is the most important local remedy we can use. The drug is, however, not well borne in every case, because, as Fuchs points out, in proportion as the iris becomes narrower and its vessels can contain less blood, the vessels of the ciliary body are overdistended, since they have to take up the blood which finds no lodgment in the iris. Hence, in such cases, we must be very cautious in the use of atropin, and must suspend it whenever we find that the pain increases after the instillation. So also, when an irido-cyclitis is combined with elevation of tension, the atropin must be stopped and, if necessary, replaced by a miotic. He also says that in cases of acute cyclitis, moist warm compresses or poultices afford the best results, especially for the relief of pain. Cold compresses are generally not well borne, and are suitable only for recent cases of traumatic iritis. Dionin introduced into the conjunctival sac in powder or in 5 per cent. solution, acts not only to relieve the violent ciliary pain, but also often exerts a favorable influence on the progress of the disease. Violent pain, moreover, is often ameliorated by the faradic current. Of internal remedies the main ones that act to relieve pain are the salicyl preparations (e. g., aspirin). Free bloodletting by means of six to ten leeches applied to the temple, or by a Heurteloup artificial leech, may very greatly diminish the inflammatory symptoms in the bad cases; not infrequently, directly after such a bloodletting the pupil for the first time yields to the action of atropin, while before this it had remained in a constant state of spasmodic contraction. If the disease lasts a long time, the bloodletting may, if needed, be repeated once or twice. One of the most efficient means both of combating the inflammation and of absorbing the exudate is energetic diaphoresis. For absorbing the exudate we may also try mercurial treatment (even in non-syphilitic cases) or subconjunctival injections of salt—the latter, however, only when

there is no marked inflammatory irritation, which might be increased by the injections.

Schiele (*Archiv f. Augenheilk.*, July, 1903) found the subconjunctival action of sodium iodide of especial value in this disease—particularly in the acute forms. He used 0.10 solutions (not boiled but freshly prepared) to which from one to three drops of 1 per cent. solution of acoin were added to each syringeful to make the injections painless. The conjunctiva was first anesthetized by instillations of cocain, or cocain and atrabilin. Pain after the injections was either very slight or entirely absent. No edema of the conjunctiva or swelling of the eyelids was seen in any case. The injections were made far back from the cornea, to avoid injuring any of the large conjunctival vessels. No adhesion between the conjunctiva and sclera, or necrosis of the tissue was observed. These injections of a syringeful of 1-1,000 sodium iodide solutions were repeated not oftener than every three or four days.—(Wood's *System of Ophthalmic Therapeutics*, p. 553.)

It must not be forgotten that large doses of sodium salicylate, after the plan advised by Gifford, associated or not with pilocarpine sweats, have proven very valuable in most forms of cyclitis. De Schweinitz has also employed full doses of quinin.

The *treatment of the complications and sequelæ* of cyclitis are elsewhere described in this *Encyclopedia* under their proper headings.

Cyclitis, Herpetic. This expression has been applied to that form of iridocyclitis that results from the so-called *zona ophthalmica*, which may be either a primary disease or secondary to a bullous keratitis. It usually shows itself as a serous cyclitis, with a deep anterior chamber, dilated pupil, plus tension, and a marked keratitis punctata. The secondary form of herpetic cyclitis is generally associated with herpes of the cornea and is usually very chronic. A favorable *prognosis* may however be given in both forms of the disease. The *treatment* is that of the so-called serous cyclitis.

Cyclitis, Heterochromic. A name suggested by Harrison Butler for those alterations in the color of the iris that almost invariably follow or accompany the subacute and chronic forms of inflammation of the uveal tract. Heterochromia of the iris is of two forms; a simple anomaly and as a symptom of a definite and rare disease with characteristic symptoms, called heterochromic cyclitis. Butler (*Ophthalmoscope,* IX, p. 501, 1911) reports such a case in which the darker eye was affected, perhaps the only one on record in which this was the case. The clinical history embraces a low grade of cyclitis, associated with copious precipitates upon Descemet's mem-

brane, rapid development of cataract, the very favorable result of the extraction and finally glaucoma, following normal operation without incarceration of iris or capsule.

Stephenson (*Ophthalmoscope*, IX, p. 631, 1911) observed a mature cataract in an eye whose blue iris was much lighter in color than the other. There were nine to twelve tiny round spots of brownish-black pigment upon the lower half of the anterior capsule. These had probably originated from the pigmented epithelium in a similar way to that found in so-called pigmented keratitis punctata. The left eye (grayish-blue iris) was normal. It is suggested by Bistis (*Arch. d'Opht.*, Vol. 32, p. 578, 1911) that paralysis of the sympathetic may be an important factor in the etiology of acquired heterochromia.

Cyclitis, Membranous. See **Cyclitic membrane.**

Cyclitis, Metastatic. This form of the disease is generally suppurative and commonly ends in panophthalmitis. The infection is carried by the blood and lymph streams from some distant focus and sets up a similar alteration in the substance of the ciliary body. A valuable paper on this subject is by W. Collins (*London Lancet*, Vol. 2, p. 1475) on metastatic suppurative cyclitis with pyemia.

Cyclitis minima. (L.) A slight form of cyclitis.

Cyclitis, Plastic. Iridocyclitis plastica. An inflammation of the ciliary body with an effusion of plastic lymph, which, among other alterations, units the surfaces of the iris, ciliary processes, and sometimes the suspensory ligament to each other, and sometimes involves the iris to such an extent as to cause posterior synechia and occlusion of the pupil.

This is the severest form of inflammation of the ciliary body. The symptoms are great pain, chemosis of the conjunctiva, and swelling of the lids. The eye is exceedingly tender to pressure over the ciliary region. There is great pericorneal injection, and exudation takes place into the pupil, behind the iris, and into the vitreous humor. Often the pupil is dilated by the contraction of plastic exudate deposited in the ciliary body. If the disease follows an attack of iritis, all the symptoms are accentuated. Early in cyclitis the tension is increased. The disease is accompanied at times by intense pain, vomiting, and fever. Photophobia and lachrymation are often present. The most frequent *cause* of plastic cyclitis is *traumatism* (perforating wound, cataract operations, etc.). It occurs idiopathically as a result of a similar process in the other eye (sympathetic ophthalmitis). Stephenson—in view of the fact that numerous inflammatory diseases of the iris and choroid result from depraved blood-

conditions, which, in turn, are attributed to microbic causes—regards the excretion of microbes or their products by the ciliary body as the cause of all cases of endogenous iridocyclitis.

The first step in the morbid process is hyperemia with transudation of leucocytes. The characteristic feature of the disease is the fibrinous exudate, which appears on the inner surface of the ciliary body, on the zonula of Zinn, in the posterior chamber, and in the vitreous humor. The inflammatory process may end in resolution, the exudate being absorbed, or it may become organized. Vessels from the ciliary body or from the peripheral parts of the retina grow into it. The iris becomes adherent to the lens, thus obliterating the posterior chamber; and contraction of the newly formed membranes with detachment of the retina and ciliary body, takes place. The nutrition of the lens being interfered with, cataract results. The eye finally becomes shrunken and soft: a condition known as atrophy of the eyeball. This form of cyclitis is rarely improved by treatment. The *treatment* is that of a severe case of iritis with the addition of large doses of mercury and potassium iodid, together with diaphoretics. Subconjunctival injections of sodium iodide, or mercuric cyanate with acoin, followed or preceded by the use of dionin and the internal administration of Gifford's salicylates may also be employed. If the eye becomes blind and shrunken and is painful to the touch, it should be enucleated.—(J. M. B.)

Parsons says that a chronic plastic cyclitis is commonly met with in the pathological laboratory. In these cases the exudate is "very rich in fibrin and is gradually organised into fibrous tissue. The ultimate result is phthisis bulbi, the picture differing in no respect from the late stages of non-suppurative acute plastic cyclitis. The intermediate stages are best seen in cases of pseudo-glioma, where the difficulty of diagnosis leads to comparatively early enucleation."

Cyclitis, Purulent. Inflammation of the ciliary body attended by an effusion of pus and (sometimes) associated with hypopyon.

This disease is caused by infected wounds and acute infectious diseases. It runs a sharp course. Hyperemia, round-cell infiltration, and the presence of pus in the anterior chamber are prominent pathologic features. The symptoms are all accentuated. If the disease is due to a wound, the eye is lost by panophthalmitis. Purulent cyclitis sometimes appears idiopathically in the course of influenza, smallpox, and scarlatina. The prognosis is unfavorable. The treatment will consist of hypodermic injections of morphin to relieve pain and the local use of atropin, hot compresses, and bichlorid solution. Inunctions of mercury and subconjunctival injections of the same

drug, as well as deep orbital injections of mercuric cyanate with acoin, may be employed. Most cases of purulent cyclitis end in phthisis bulbi and require enucleation.—(J. M. B.)

Cyclitis, Serous. Cyclitis serosa. Descemetitis. Aquocapsulitis. Keratitis punctata. Serous iridocyclitis. Inflammation of the ciliary body, in which the effusion is almost entirely serous, causing at first increased tension and a haziness of the vitreous and occasionally of the aqueous humor. In this form of cyclitis the corneoscleral region shows a delicate rose-colored injection. The anterior chamber is of normal or increased depth. The pupil is of normal size or slightly dilated. The tension, slightly increased at first, diminishes later. The tendency to the formation of posterior synechiæ is not so marked as in iritis. The iris reacts slowly to light. Pain is rarely a prominent symptom. Exudation into the anterior chamber is moderate in amount, causing the aqueous and cornea to become cloudy. A deposit of opaque dots, often arranged in triangular form with the base downward, appears on the posterior elastic lamina of the cornea. The visual field may be contracted. A central scotoma may be present.

Serous cyclitis may exist alone, but generally it is found associated with choroiditis, interstitial keratitis, or scleritis.

The disease occurs chiefly in ill-nourished, anemic young persons, particularly in women suffering from uterine diseases. According to Horner, it is more frequent in women than in men in the proportion of 10 to 3. Some cases are undoubtedly due to syphilis, either early or as a late manifestation, while others have been attributed to rheumatism, gout, eyestrain, or to trauma. A serious form of this affection is caused by sympathetic ophthalmitis.

The investigations of Nicati, in 1891, showed in rabbits the existence of glands in the ciliary body for the secretion of aqueous humor. Treacher Collins, working about the same time, demonstrated by bleached sections the existence of similar glands in the human eye. Serous cyclitis is a catarrhal inflammation of the ciliary glands. Hyperemia is followed by increased secretion and deepening of the anterior chamber. The aqueous humor becomes more albuminous than normally. A few leucocytes, together with pigmented epithelial cells thrown off from the surfaces of the glands, and shreds of fibrin are present. These solid elements drop to the bottom of the anterior chamber and form the dots of so-called "keratitis punctata." Leucocytes collect in the ligamentum pectinatum and hinder the egress of aqueous, thus causing increased tension. The turbidity of the aqueous humor causes the iris to lose its lustrous appearance. Severe cases may end in involvement of the vitreous humor with shrinking of the globe and development of cataract.

For a further description of the pathological changes in this form of the disease, see **Cyclitis.**

Except as a manifestation of sympathetic ophthalmitis, serous cyclitis offers a favorable prognosis. Adhesions do not often form between the iris and lens-capsule, but sometimes permanent opacities are left in the cornea and vitreous humor. The disease runs a slow course. When associated with marked fundus changes it may lead to blindness.

The internal use of mercury and potassium iodid is of value in these cases. Mercury used by inunction or hypodermically is an efficient remedy. If the patient is anemic, tonics are to be employed. In the cases due to gout and rheumatism, Turkish baths, diuretics, tonics, and exercise, together with appropriate diet, are to be employed. As regards local treatment, the use of weak solutions of atropin is of value. If the tension is increased, paracentesis of the anterior chamber should be done, followed by the use of pilocarpin, arecolin, or weak eserin solutions. The presence of vitreous opacities will call for the vigorous use of mercury and diaphoretics internally. Use of the eyes for near work should be prohibited. As a rule, the patient should not be kept in a dark room.—(J. M. B.)

Cyclitis, Sympathetic. Cyclitis due to sympathetic ophthalmitis. This form of inflammation of the ciliary body occurs in sympathetic or migratory ophthalmia and is chronic in character. As is well known, the "exciting" eye is not uncommonly attacked with an ordinary form of acute cyclitis, almost invariably the result of a penetrating injury of the eyeball. It may, however, result in a more chronic form of iridocyclitis. As Parsons (*Pathology of the Eye,* p. 353) points out, there is another group of cases in which the inflammatory signs are few and not well marked. In these instances he says: "There is no keratitis punctata, and only slight irritability, manifested by lachrymation and transient ciliary injection. In one such 'dangerous eye' which I have had the opportunity of examining, there were nodules of lymphocytes in the iris and ciliary body—a condition which is not uncommon in chronic inflammation, and may be called *nodular irido-cyclitis* for the sake of distinction. The nodular aggregations are commoner in the iris and choroid than in the ciliary body; they may contain numerous giant-cells, as well as epitheloid cells, so that the resemblance to tubercle is very striking; this occurs more frequently in the choroid than in the ciliary body or iris. The observation of giant-cell systems was first made by Krause (1881), and has since been confirmed by Schirmer, Axenfeld, Pincus, and many others. The giant-cells are often very large, and

have many nuclei, which are usually arranged irregularly, but may assume the Langhans type. The conditions found in the ciliary body of the sympathizing eye in the cases which have been examined are, apart from the injury, identical with those in the exciting eye. Sympathetic serous cyclitis has been examined in one case only (Grunert's case, Schirmer); keratitis punctata and infiltration of the whole uveal tract were present. In other cases nodular deposits of lymphocytes, with or without epitheloid and giant-cells, have been observed."

The *treatment* of sympathetic cyclitis is involved in the treatment of migratory ophthalmia plus that of the particular form of the disease that manifests itself as the result of the sympathetic affection. See **Sympathetic ophthalmia.**

Cyclitis, Syphilitic. This form of the disease shows itself as a papular or secondary form of the original infection, or it may appear as a true gummatous (tertiary) manifestation. In any event, it is almost always an accompaniment of a well-marked syphilitic iritis. The gummata have been recognized in the ciliary tissues. The prognosis is relatively favorable and the treatment is that of cyclitis in general, with the addition of antiluetic remedies.

Cyclitis, Traumatic. CYCLITIS FOLLOWING OCULAR CONTUSIONS. Many authors confine this term to the lesions resulting from *non-penetrating* wounds of the ciliary body. The usual signs and symptoms of cyclitis are, however, rarely seen after mere contusions. However that may be, the probability is that all cases of genuine traumatic iritis are more or less complicated by a cyclitis. Parsons (*Pathology of the Eye*, p. 1147) believes that the haziness brought about by exudates in the aqueous must be attributed to traumatic iridocyclitis, and that there is little doubt that the vessels of the ciliary processes often suffer severely. It must be remembered that precipitates on the cornea are evidence usually of a subacute or chronic process, and this is generally absent in these cases. The outcome of the injury to the ciliary body is the failure, more or less pronounced, of its normal functions, especially that of the secretion of the intraocular lymph, and this manifests itself unmistakably in a large number of cases by diminished tension. Whether this is dependent upon paralysis of the nervous mechanism, rendered the more probable by the frequency of simultaneous paralysis of accommodation, but discounted by the negative evidence of experimental investigation, or upon direct injury to the secretory apparatus, must remain obscure in the present state of knowledge. The latter view has most in its favor.

The treatment of this condition is that of traumatic iritis. If taken early and if it is not complicated by organic lesions of the interior of the eye, the prognosis is quite favorable.

Cyclitis, Tubercular. This form of the disease may show itself as a serous-plastic iritis, in which the punctate deposit on Descemet's membrane is not very well marked; or it may appear as tubercular nodules in the ciliary body in the form of miliary tubercles. Tubercular cyclitis is much commoner as a secondary affection than as a primary disease; consequently the *prognosis* is not as a rule favorable. The *treatment* is that of ordinary serous iritis, plus general and local antitubercular therapy.

Oscar Dodd and Francis Lane (*Jour. Am. Med. Assocn.*, July 22, 1911) have described a tuberculous cyclitis following a non-perforating wound of the eye. See, also, **Injuries of the eye.**

Lebouc q (*Trans. Belg. Oph. Soc.*, April 28, 1912), has analyzed five cases of cyclitis without iritic lesions, of tubercular origin. He says that, as a rule, the onset is sudden; there is slight pericorneal injection; the centre of the cornea is faintly clouded, and the deposits on Descemet's membrane which become larger and larger, soon give the classical picture of Descemetitis. At the end of two weeks the deposits begin to clear up and continue so for several months. The deposits are due to tiny masses of cells thrown off by the inflamed ciliary body; these products are transformed into brown spots composed of grains of pigment.

Tuberculin treatment, he thinks, does not seem to influence this condition.

Cyclitis, Vasomotor. A form of inflammation of the ciliary body described by Samelsohn, and referred by him to some lesion of the sympathetic nervous system. The tension may be either increased or diminished. There is no pain on the corresponding side of the head, marked ciliary neuralgia and injection, and sometimes a herpetic eruption on one side of the face.—(Foster.)

Cyclitis with keratitis punctata. Cyclitis serosa.

Cyclochoroiditis. Combined inflammation of the choroid and ciliary body.

Cyclochrome. A name given to a form of perimeter, devised by Ballabon. It is said to bring about a rapid change of colors, and to be handier and more exact than the ordinary perimeter. See the abstract in the *Annals of Ophthalm.*, Vol. 8, 1899, p. 127.

Cyclodialysis. Operative detachment of the ciliary body. Heine (*Deutsch. Med. Wochenschr.*, No. 21, 1905) devised this operation for glaucoma, which consists in detaching the ciliary body from the

sclera to establish a communication between the anterior chamber and suprachoroidal space and to reduce the intraocular tension. He claimed this action for his operation even if several iridectomies or sclerotomies had been performed without success, and in absolute glaucoma with intense secondary changes. Krauss (*Zeitschr. f. Augenheilk.*, 1907, p. 318) pertinently asks whether through cyclodialysis a dehiscence is obtained which leads to a lasting communication between the anterior chamber and suprachoroidal space and whether the aqueous is excreted from the latter out of the interior of the eye. Whether cyclodialysis is able to free the sinus of the anterior chamber, and whether this is effected better and easier by cyclodialysis than by procedures now in vogue and tested in many operations is also questioned.

Since no experiments on animals had hitherto been made to answer these questions, Krauss undertook them on 20 eyes of rabbits and 12 eyes of cats. In all cases a solid cicatrix formed at the site of the operation; the vitreous occasionally showed here and between it and the ciliary body slight fibrous bands. The choroid was always tightly adherent to the sclera; the ciliary body was fixed to the sclera by scar tissue, and the ciliary processes were thickened by cicatrices or atrophic. The iris occasionally appeared atrophic in the region of the detachment and always was adherent to the cornea; the sinus of the anterior chamber was in all cases obliterated; the base of the iris was always adherent to the cornea by cicatricial tissue extending far forwards. The anterior chamber at the site of the cyclodialysis was more shallow and in the sinus fibres and leucocytes were found. The cornea showed detachment of the endothelium and Descemet's membrane, which not infrequently happened at the operation. A lasting corneal opacity resulted in some animals.

Heine's cyclodialysis produces in the eyes of rabbits and cats cicatricial synechiæ between parts which had been separated by the operation. The substitution of the destroyed normal tissue by scar tissue causes atrophic changes on the detached parts of the eye.

The writer also details the clinical histories of two cases of glaucoma, operated on by cyclodialysis, with anatomopathologic descriptions of the enucleated eyeballs, which also showed that cyclodialysis does not establish a lasting communication between the anterior chamber and the supra-choroidal space.

Later, Meller (Graefe's *Archiv f. Oph.*, Feb., 1908) fully described and discussed the operation. After thorough cocainization the conjunctiva and capsule of Tenon are dissected up so that a small area of the sclera, about 5 mm. from the corneal limbus, is exposed. An

incision is made through the sclera parallel to the margin of the cornea and preferably down and out and not longer than 2 mm. This incision is made with a lance knife, slowly and carefully without pressure, to avoid injury to the uvea. That the sclera has been penetrated can be told by the release of the resistance and the appearance of the uvea in the bottom of the wound and the fact that the slightest movement of the instrument on the ciliary body causes pain. During this procedure the eye is rotated strongly upward and fixed by forceps. Hemorrhage may be annoying and can be controlled by adrenalin. Should a ciliary vessel be cut it may be seared by the thermocautery. The second step consists in the introduction of an iris spatula into the wound and carrying it forward between the sclera and ciliary body. Difficulty in this maneuver may result from entanglement of the tip of the instrument in incompletely divided fibres of the sclera. The instrument is entered somewhat obliquely and as soon as it has passed through the sclera it is made parallel with the surface of the sclera and pushed on gently until its tip appears in the anterior chamber.

The third step consists in the separation of the ciliary body from the sclera. This is accomplished by giving to the spatula a side to side movement. The separation extending from the vertical meridian below to the horizontal meridian on the temporal side. The spatula must not be entered further into the anterior chamber than to permit of its tip being always visible. After the undermining is completed the spatula is brought back to its primary position and slowly withdrawn. No resistance is met with in undermining unless: (a) Scleral fibres arrest the point of the spatula. This will take place while the tip is still within 1 mm. of the opening. (b) By a nerve or blood-vessel passing from the sclera to the ciliary body. All hemorrhage should have ceased before withdrawing the spatula lest the blood be sucked into the anterior chamber. A certain amount of hemorrhage is apt to follow so free a separation of the ciliary body and an attempt should be made to control it with the finger. After completion of the operation a pressure bandage should be applied for 8 hours. (c) Resistance can be felt when the spatula impinges upon the scleral insertion of the fibres of the ciliary muscle. (d) Resistance to the advance of the spatula through the penetration of its point between the membrane of Descemet and the corneal parenchyma. From this an opacity results which, however, slowly disappears. It is due to a swelling of the parenchyma itself. It appears to be a frequent complication of the operation. A fifth, but unimportant obstruction is the union of the root of the iris to the posterior

surface of the cornea. This may lead to the production of an iridodialysis, but it will not have any sequelæ.

Two complications which, however, seldom occur, are: 1. Too rapid cutting through the sclerotic when that membrane is pathologically thin, and the incision placed too far from the limbus may cause a prolapse of the vitreous. 2. The operator, instead of keeping to the scleral wound, penetrates the uveal tract so that the spatula comes out behind the iris.

Injury to or luxation of the lens should not be possible. The full effects of the operation are reached gradually in from 1 to 3 days. The effects may be divided into three groups: 1. Permanent unfavorable result. 2. Transient result. 3. No effect whatever.

In Meller's series 40 per cent. fell within the first group. This is in a measure explained by the character of the cases which at first were chosen for operation—absolute glaucomatous eyes. The second group contained 30 per cent. of the cases. In the third group were mostly cases of absolute glaucoma, in one instance glaucoma secondary to a choroidal sarcoma. This group contained about 30 per cent. The indications for the operation are primary as well as secondary glaucoma, except such cases of secondary glaucoma arising from seclusio pupilæ, iris bombé, etc. In adherent leucoma it is very serviceable. In dislocation of the lens the operation is strongly indicated.

It cannot be said that the operation of cyclodialysis will take the place of iridectomy, and that the presence of primary glaucoma calls for the performance of the operation. The real indication for it is the impossibility of performing iridectomy from the presence of very high intraocular tension and absolute glaucoma which has progressed far.

An elaborate exposé of the advantages of the operation is also furnished by G. Wernicke (*Klin. Monatsbl. f. Augenhlk.*, Nov.-Dec., 1908). This paper has been abstracted and commented on by H. Herbert in the *Ophthalmic Review* for July, 1909, as follows: There are more or less detailed reports of sixty-one patients operated upon by cyclodialysis at Breslau, including the later results of twenty cases already published by Heine. And the published accounts up to date of experiences of cyclodialysis elsewhere, mostly less favorable, are reviewed and criticized from the Breslau standpoint. The arguments are, therefore, all on the one side. Failures and drawbacks are explained away.

Krauss opposed the operation mainly from the histological examination of rabbits' eyes experimented upon. Wernicke points out

that the sclera and ciliary body are too thin in these eyes to be very suitable for the experiment. (Even dogs' eyes, four of which were operated upon and examined by Wernicke and Heine, are somewhat unsuited owing to the hemorrhage which is occasioned from the free venous plexus in the sclerotic near the corneal margin). The fibrous bands which were found by Krauss in the vitreous, and the marked atrophic changes in the ciliary body, were attributable to wounding of the vitreous and of the choroid. It is possible that atrophy of the small separated portion of the secretory apparatus of the eye may partly account for reduction of tension.

From the few glaucomatous eyes which have as yet been examined after this operation, it is not possible to state whether the procedure can re-open the angle of the anterior chamber. Nor is it easier to determine the permanency, or otherwise, of the connection established between the anterior chamber and the suprachoroidal space. This space is not readily shown in histological preparations of normal eyes; it must be still more difficult to demonstrate in eyes with raised tension. In a dog's eye, enucleated forty-eight hours after cyclodialysis had been performed upon it, Wernicke found the ciliary body and choroid for the most part closely applied to the sclerotic. Even after operation upon freshly enucleated pigs' eyes, sections of the hardened and embedded eyes failed to show the suprachoroidal space with certainty. It is probably owing to this early readjustment of the tissues that detachment of the choroid has been observed clinically only twice by Heine after this operation, and not at all by others. Such detachment is also too peripheral to be easily seen.

As regards the five operations—all failures—reported by Weekers from Axenfeld's clinic, we are reminded that they were all done upon cases admittedly unfavorable for operation.

Among Boldt's thirty-seven operations from Deutschmann's clinic only six were entirely without result. More or less diminution of tension was obtained in all the others, and in twenty-five of the cases the reduction was lasting. Boldt concluded that in no case had the operation presented any particular difficulty and in no case had it caused any permanent injury to the eye such as might have prejudiced subsequent operation by this or other method. This operation was apparently especially to be considered in cases where the visual field was much contracted.

The forty-eight cases published by Meller from Fuch's clinic showed that the new operation, apart from the cosmetic and optical advantages of the round pupil, was preferable to iridectomy in certain cases because in them it was decidedly less dangerous. It was

to be chosen in very hard eyes with very shallow chamber, in all hemorrhagic glaucomas, and where the fellow eye had been lost through malignant glaucoma or thorough severe hemorrhages following iridectomy; in aphakic eyes with fluid vitreous; and in hydrophthalmic eyes. Thus we might escape such dangers as that from prolonged emptiness of the anterior chamber, loss of vitreous, injury of the lens, and profuse intraocular hemorrhage. It was to be preferred also in cases where the iris was atrophic, or where iridectomy had already failed. Meller had concluded that cyclodialysis was a valuable means of treatment in some cases where no other operative measure was applicable. And it could be repeated several times if necessary.

In all, seventy-six cyclodialysis operations were performed at Breslau upon sixty-seven eyes, six patients having both eyes treated, and nine eyes having repeated operations.

There were eleven operations on nine acutely glaucomatous eyes. From these there were six satisfactory results, but only three of them were observed for over a year; two transient reductions of tension; and three operations without results.

There were four hemorrhagic glaucomas treated. There was one good result, observed however for less than a year, one transient effect, and two without influence on the tension.

Among subacute, chronic and absolute glaucomas there were thirty-six operations on thirty-one eyes. These gave twenty good results, but only twelve of them had been seen for a year or more. There were eleven temporary reductions of tension, and five cases were uninfluenced.

There were nine operations on seven buphthalmic eyes: five with satisfactory effect, four of these having been seen more than a year later; two with only temporary benefit; and two without influence.

There were nine eyes treated for chronic simple glaucoma, giving five good results; only one of these, however, had been observed for a year. There were three cases of transitory relief and one ineffectual operation.

Five cases of corneal staphyloma with secondary glaucoma were all relieved.

There were two traumatic glaucomas. In one the tension was unrelieved; the other case ended in phthisis bulbi.

Of the total operations, therefore, 57 per cent. were successful so far as observed, and about half of these cases had been tested a year or more later. There were 25 per cent. of temporary reductions, and 18 per cent. of the cases were uninfluenced. But of the fourteen glaucomas forming this last group, three were cured and four

temporarily relieved by second operations. Of the remaining seven complete failures, six were in eyes which had already been unsuccessfully and in some cases repeatedly operated upon by other methods. It is especially to be noted that in two cases the anterior chamber had failed to refill after previous iridectomy and sclerotomy; it re-formed, however, after the cyclodialysis.

A few words are added upon operative technique. Latterly the scleral incision had been placed 2 or 3 mm. farther back than formerly, in order to obtain a larger sweep with the stylet, and so to detach more of the ciliary body. And, especially in the later cases, a drop of ½ per cent. eserin solution had been instilled after operation, to increase the separation of the tissues by drawing the root of the iris away from the sclera.

As regards complications, hemorrhage into the anterior chamber is soon reabsorbed. Bleeding into the vitreous is usually met with only in the most acute inflammatory and in hemorrhagic glaucomas —cases in which iridectomy is also liable to give rise to profuse destructive hemorrhage. Severe iritic reaction is confined to severe inflammatory cases. Small wounds of the iris are of no consequence, and accidental iridodialysis may be actually advantageous. Perforation of the choroid is not to be feared with a very small scleral incision. Choroidal prolapse has been observed only in hydrophthalmic eyes with thinned sclerotic. Cloudiness of the cornea from injury to the endothelium is mostly transient, and is situated too peripherally to be of any importance.

On the whole these results cannot be considered very impressive or convincing. And it would perhaps serve to prevent possible misunderstanding if the purely temporary reductions in tension were grouped with the complete failures. The prospect of cure, even by the later operations with rather more extensive separation of the ciliary body, is scarcely sufficiently assured to make it appear probable that cyclodialysis can replace simple iridectomy in the treatment of the more common types of glaucoma, even though the newer operation may be somewhat safer. But this, after all, is not the main point. The future of cyclodialysis as a means of treating the ordinary run of glaucomatous eyes must depend apparently upon its power to compete, not with simple iridectomy, but with the "filtering cicatrix" operations. The possibilities of the latter, with regard to safety, certainty and uniformity of result, are certainly great, though these possibilities have been little explored as yet. The small incisions required for these operations together with slow evacuation of aqueous, make for safety. And the promise of uniform effectiveness

is such that in the future we can be satisfied with nothing less than almost mathematical certainty in the reduction of tension.

One feature of cyclodialysis may however secure for it a permanent place in the treatment of limited groups of cases. The gradual reduction of tension brought about by cyclodialysis, in some cases at least, is greatly in favor of the procedure in eyes with diseased blood-vessels, perhaps also in eyes with very limited visual fields and in hydrophthalmic eyes. In these last, however, the readiness with which permanent leakage may be secured through the greatly thinned sclerotic by means of minute subconjunctival paracentesis openings, has not yet been sufficiently realized.

The *Ophthalmic Year Book* of 1911 and 1912 reviews the opinions of various observers for these years. Steindorff (*Berl. klin. Woch.*, Vol. 47, p. 1837, 1910) concludes that the published experience regarding this operation is quite favorable, although nearly all writers regard iridectomy as the operation of choice for acute and subacute primary glaucoma. Cyclodialysis may be tried when iridectomy fails. Elschnig (*Klin. Monatsbl. f. Augenheilk.*, Supplement, p. 1, 1910, and *Ophthalmoscope*, Vol. 9, p. 135, 1910), reporting an experience of eighty-six eyes, some subjected to the operation three or four times, finds that it is more painful than iridectomy, but rarely produces bad effects. He regards it as a valuable addition to the operations for glaucoma, especially for simple glaucoma, hydrophthalmos, secondary glaucoma, or where iridectomy cannot be done, or has failed. But he refrains from drawing any final conclusions regarding it. Zentmayer (*Ophth. Record*, Vol. 19, p. 206, 1910) has tried the operation in four cases, in three of which tension was reduced to normal and central vision and the visual field improved. Pyle (*Ophth. Record*, Vol. 19, p. 190, 1910) emphasizes the simplicity of the operation. He finds the statistics regarding it vitiated by its application chiefly to cases from which little or nothing was to be hoped from iridectomy. Brown (*Ophth. Record*, Vol. 19, p. 329, 1910) has reported a case favorably influenced by it.

As completely successful the authors reckon only those cases in which, after at least three to six months observation, the tension stayed normal and no deterioration occurred in vision or the visual field. These conditions were fulfilled by fifteen cases, of which five were observed for at least six months and seven for not less than a year. Two out of three of the conditions were satisfied by five further cases. Relapses occurred in ten cases which had for a time appeared successful. As regards the relative efficiency of the operation in chronic and acute glaucoma, joint consideration of the com-

pletely and incompletely satisfactory results suggests that the prospects are most favorable in glaucoma simplex. A comparative study of results of iridectomy and of cyclodialysis done (a) each in one eye of the same patient, or (b) in the order named on one and the same eye, does not argue in favor of either mode of treatment.

Waldstein (*Klin. Monatsbl. f. Augenheilk.*, May-June, 1911, p. 749), reporting on 176 operations done in the Elschnig clinic, also speaks with especial favor of the use of cyclodialysis in glaucoma simplex. But in secondary glaucoma only those cases which are due to luxation or subluxation of the lens appear to be suited for this procedure.

The results of a series of fifty-four cyclodialysis operations, done in the years 1910 and 1911 at the Königsberg clinic, are carefully analyzed by Meisner and Sattler (*Archiv f. Augenheilk.*, Vol. 71, p. 34, 1911). These authors regard the operation as easier of execution than iridectomy, especially when the anterior chamber is shallow. Although the ciliary body was detached by means of a flat spatula for about a third of its circumference, in only one instance was the shape of the pupil altered. In fifteen cases the operation was complicated by hemorrhage into the anterior chamber, usually from ruptured anterior ciliary vessels. In eight cases the hemorrhage was absorbed within fourteen days and the results were good. But the operation was unsuccessful in the other seven cases, in which absorption was slower. Accidental perforation of the uvea did not generally appear to spoil the result. Most of the patients were free from pain after the first few hours following the operation. Partial atrophy of the iris was seen in one case about a year after operation. Post-operative inflammation occurred in an old trachomatous eye, and again in a case of glaucoma following cataract extraction. See, also, **Glaucoma (operations for).**

Cycloduction. The intrinsic power of each oblique muscle, or of both superior obliques, or of both inferior obliques. See, also, **Muscles, Ocular**; and **Cyclophorometer.**

Cycloid. A plane curve generated by a point in the circumference of a circle rolling upon a straight line.

Cyclopanophthalmia. Cyclopia with one orbit and perfect or imperfect eyelids, without an eyeball.

Cyclopenauge. (G.) A cyclops.

Cyclopes, The. In classical mythology, a fabulous race of giants, who had but one eye, which was large and round and was situated in the centre of the forehead. From these anatomical circumstances, indeed, they had their name. According to Homer, Ulysses, leaving the land of the Lotophagi, or lotus-eaters, sailed westward, and

eventually arrived at the country of these monocular giants. They were a barbarous, and even murderous, race, who lived, each to himself, with his own family, in a cave on the side of some lofty mountain. One of the Cyclopes, Polyphemus by name, captured Ulysses and twelve of his companions, and shut them up in his cavern. Ulysses, however, having intoxicated the giant, put out his one eye, and so, with his companions, was enabled to escape.—(T. H. S.)

Cyclophoria. This form of heterophoria is an insufficiency of the oblique muscles, giving the eyes a tendency to roll outward or inward, so that the naturally vertical meridians diverge either at the upper or lower extremities.

Savage (*Ophthalmic Myology*), Worth (*Squint,* pp. 169 and 189), as well as various papers by A. A. Bradburne give the best account of this form of oculo-muscular defect.

The last named writer's early article (*Ophthalmology,* Jan., 1911) on this important subject deserves almost complete reproduction here. He believes that constant and sustained over-action on the part of any muscle or set of muscles entails a severe drain on the nervous system. When the cause which gives rise to this strain is unrecognized the results are further aggravated, for the simple reason that the pernicious action persists despite the futile attempts to counteract the results. It is the small, inconsiderate and seemingly trifling optical defects that give rise to the most trouble; hence it is amongst those minor degrees of astigmatism or muscle imbalance that can be neutralized by a slight excess of muscular effort that one finds the evidences of strain. The smaller the error the less noticeable it is, and naturally the longer it lasts before becoming manifest, and the greater degree of mischief it entails.

By cyclophoria we really mean a tendency to abnormal rotation of one or both eyes about a fore-and-aft axis. To make this plainer one must recall to mind the axes around which the eyeball moves. They are three. One a vertical axis in which the motion of the eye is similar to that of a weather cock: a second around a horizontal axis, in which the motions are the same as those of a looking-glass, and third one round an antero-posterior axis forming a wheel-like motion. It is this last or wheel-like motion to which cyclophoria refers. The movement itself about this fore-and-aft axis is known as torsion, and before we can fully appreciate the condition of cyclophoria we must understand the various factors that have to do with torsion.

The principles bearing upon the subject of the turning of the eye upon its own antero-posterior axis are complicated.

There are two axes about which torsion can take place; viz., an antero-posterior one drawn through the center of the eyeball itself and corresponding to the visual axis and a second belonging to the socket of the skull and the head itself; some authorities deny that any rotation takes place about the former axis. The agents which bring about torsion of the eyes are the superior and inferior recti and the oblique muscles.

For certain positions of the eyes a certain degree of torsion is normally present.

This is best seen if we examine the position of the eyes when the line of regard is directed down and in, as for instance in the act of reading or writing. Here the eyeball will be drawn in by the action of the interni recti muscles, down by inferior recti which will at the same time, owing to their relation to the eye, also rotate the vertical meridian outwards. Now the superior oblique will also assist to move the eyeball down and at the same time rotate the vertical meridian inwards, in this respect neutralizing the torsional effort of the inferior rectus.

We thus see that in this position, with the lines of regard directed down and in, that the interni recti act as convergers and the inferior recti act as depressors and also as tilters of the superior end of the vertical diameters of the eye outward.

To counterbalance this torsion a compensating action on the part of the obliques is necessary and as their action is an entirely independent one, governed by the will, any special compensatory effort must entail a strain on the nervous system.

In the interest of clear vision when the gaze is thus directed, a certain amount of tilting out of the meridians is necessary and as the three pairs of muscles act almost automatically, the agency of the obliques is practically just equal to the demands for modifying the tilting. When, however, certain circumstances arise in which the compensatory tilting action of the obliques is called into excess, it gives rise to further complications: for in addition to their torsional effects the obliques have power to modify the rotation, elevation and depression of the eyes. In the circumstance under consideration with the gaze directed downward and inward an excess of action on the part of the obliques would also restrain the converging action of the interni and supplement the depressor action of the inferior recti. Perhaps if one takes for example the reading of a line of type in a book it may help to simplify the subject. Here the gaze is directed down and in and on each retina is received a horizontal image of the line of letters. If the impression fall equally on corresponding parts

of each retina, but one impression will be received by the brain. Consider, however, what happens if any abnormal torsion be present; here the horizontal lines of letters will appear to cross each other, owing to the fact that they do not fall upon the correct portions of each retina. It is true that this phenomena of crossing of the lines of type is not recognized, as the desire to obtain fusion is too strong to permit double vision except in high degrees. To overcome this want of alignment of the lines a special effort on the part of the obliques becomes necessary, and this special effort, as we have shown, entails also alterations in the horizontal elevation and on the lateral position of the eyes. Thus it is plainly seen that in any individual in whom an abnormal state of torsion exists, viz., the condition of cyclophoria, a very great strain is thrown on his ocular muscles by the efforts made to maintain convergence on a near object.

If a condition of cyclophoria is present when the gaze is directed at a near object, the neutralizing action of the obliques will, when the convergence is maintained for any lengthened period, lead to a tendency for these muscles to become fixed in their fresh position. Hence, when once more the gaze is directed straight ahead, or for other positions, a state of torsion will be present which did not exist before. Thus it is plain that if, by inadvertence or ignorance of the laws relating to torsion, we produce a condition of cyclophoria for near vision, we at the same time add also the same for distant sight. We now come to the consideration of the causes, detection and treatment of cyclophoria.

As the maintenance of the horizontal or vertical meridians of the eyes is dependent on the accurate adjustment and action of the oblique muscles, any affection of these muscles or their nerve supply will produce a condition of cyclophoria.

Another cause of cyclophoria is the faulty prescribing of cylindrical lenses. Many medical men, to say nothing of the prescribing optician, are daily accustomed to prescribe glasses and are constantly, yet unknowingly falling into the error of incorrectly ordering the axes of the cylinders. Since without glasses a torsion naturally takes place when the eyes move from the primary position of looking straight in front, if then the eyes have to look through a cylinder which was correct for the primary position it is obvious that it cannot be in the correct axis for the eyes when directed for a near point.

When the cylinder is of small amount the extra action of the obliques, to correct the torsion, will alter the line of elevation only a little, and for near work this can be compensated by altering the tilting of the head. When, however, the cylinder is a strong one or

only present in one eye the effects of the torsion will be all the greater and therefore the more difficult to overcome.

As to the *methods of detecting and treating* the condition. The complaint of certain objective phenomena on the part of the patient may lead us to suspect the presence of cyclophoria. He may say that the margins of his book are not parallel, that the edges tend to slope toward each other either at the top or bottom. Again he may complain that after much near work when he comes to lift his head up that the ground is not level. This symptom is very important and the nature of the torsion can be gauged from the direction in which he says the ground seems to slope. Symptoms of general nerve debility appearing in a patient wearing glasses and doing much near work should always lead one to investigate for the presence of the condition.

As regards the detection and correction of cyclophoria arising from the faulty position of a cylinder, it fortunately is not difficult. It can be detected by the simplest of objective testing in those cases where it is of sufficient amount to give rise to much trouble. Seat the patient in a good light and put on the trial frame with his reading lenses accurately adjusted for near work. In his hands put a large, clean sheet of neutral tinted paper, on which draw a single straight line, opposite one eye insert in the trial frame a double prism with the bases opposite the centre of the pupil. Cover the eye which has not the prism in front of it. Then ask the patient to move the sheet of paper about in front of him until he sees two lines. Two lines will be seen owing to the action of the double cylinder in front of this eye. It is obvious then that on uncovering the fellow eye three lines will be seen, the middle one belonging to the latter eye. Ask the patient to state exactly whether the middle line is parallel or if it slopes. If it be parallel no cyclophoria for near vision exists. If, however, it slopes, then slowly move the cylinder in the direction which brings this middle line into parallelism with the others. When such has been obtained cover up the prism covered eye and see if the patient can, with the cylinder in this new axis, read the small type of the ordinary reading test. If he cannot, move the cylinder back again a few degrees and test once more for parallelism with the double cylinder. When the axis is found in which the small letters can be read and the three lines are parallel this then is the correct axis in which the cylinder should be ordered for near work.

The test is a very simple one and at the same time informs one of the presence of excess or deficiency of convergence. This feature

is elicited by ascertaining whether the ends of the three lines are flush. If the center one projects to the opposite side beyond the other two, the convergence is deficient; if it projects over towards the same side as the eye without the prisms on, then excess of convergence is present. Which of these conditions is present can easily be ascertained in another way by putting prisms in front with the apex in or out until the lines are brought flush.

Instead of using a single line, a line of very small letters with a single larger letter in the middle can be employed, at the same time, when testing, it is necessary to ask the patient to name the letters. By this means we stimulate the ciliary muscle and, as the actions of convergence and accommodation move *pari passu,* an excess of accommodation will also show its effect on the balance of the eyes for convergence or on the torsion. See, also, another paper by Bradburne (*The London Lancet,* Mar. 15, 1913); as well as **Oblique astigmatism**; and **Cyclophorometer.**

Cyclophorometer. Brewster's torsiometer. A modification of the instrument first exhibited by Price, in 1893, for the measurement of cyclophoria and some other kinds of heterophoria. According to Savage (*Ophthalmic Myology,* pp. 69-72), the original instrument consisted of a double prism (line of bases horizontal) and a rod at right-angles to this line of union, placed in a circular disc to fit the rim of a trial frame, and a Maddox rod (placed vertically) in the other side of the frame. See Vol. II, page 1290 of this *Encyclopedia.*

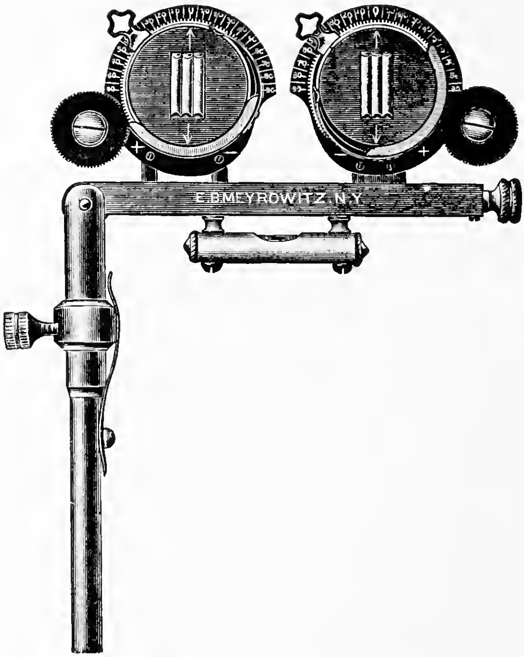
Savage's cyclophorometer consists of the equivalent of a two-cell trial frame with revolving cells mounted so the pupillary distance may be varied by a set screw at the end of the supporting bar. The arm carrying the cells is provided with a leveling attachment and a spirit level.

In examining for cyclophoria a multiple Maddox rod is placed in each of the revolving cells and a 5-degree prism, base up, behind one of them. The patient sees two horizontal lines of light, which should be parallel and the ends even. The latter can be regulated by varying the pupillary distance. If the lines are not parallel they may be made so by rotating either Maddox rod, the kind (plus and minus) and degree of the error being shown on the scale.

Cycloduction, the intrinsic power of each oblique muscle or of both superior or of both inferior obliques, may also be measured. (See the accompanying figure.)

A cyclophorometer, for use in connection with the trial frame, has been devised by Wray (*Ophth. Soc. U. K.,* Vol. 32, p. 162, 1911). It consists of two metal discs, rigidly connected. In the centre of

each is mounted a multiple Maddox rod, which can be rotated to any angle. Either rod can be set at any desired angle, and the patient required to observe whether the streaks of light are seen single, or inclined one to the other. He has used the instrument to ascertain



Savage's Cyclophorometer.

why cylinders cannot be worn with comfort, or, if comfortable for distant vision, cannot be used for reading. See, also, **Cyclophoria.**

Cyclopia. A defect of development in which there is apparently but one eye, though minute investigation generally reveals the presence of the second eye, at least in part. The cyclopic eye is usually in the lower middle part of the forehead. The formation of the interpalpebral aperture, which is of a rhomboidal form, indicates at least the rudimentary presence of four eyelids. See **Congenital anomalies of the eye.**

Cyclopic image. G. Ovio (L'image cyclopique dans le miroir plan, *Archiv. d'Ophtal.*, 1911, Vol. 31, p. 710) means by it seeing only one eye when looking at a plane mirror. The phenomenon results from fixing a point instead of the image itself. It is best seen at 1 metre distance, though it may be seen at a greater or less dis-

tance. Accompanying the cyclopic image is a distortion of the face, which is seen double.

If fixation is maintained for a short time, the two lateral eyes will disappear, leaving a facial image without nose, with deformed mouth and with only one eye. The phenomenon is primarily due to the superimposing of the right eye of one upon the left eye of the other diplopic image. Disappearance of the lateral half of each image results from abstraction, the psychic process by which impression fails to be translated into sensation.

It may also be explained by the assumption of a combination of diplopia and abstraction; diplopia, because one is looking at objects at different distances, and abstraction, because the image seen by each eye can be made to appear and disappear, finally replaced by that of the median eye.

Cyclopion. A term, ascribed to Aristotle, to designate the white of the eye.

Cycloplegia. Paralysis of the ciliary muscle. This condition is most commonly the result of the action of such cycloplegic (q. v.) drugs as belladonna and its derivatives, but it may be due, in addition, to disease of the ocular nervous apparatus, and to numerous other causes discussed under their proper headings. As de Schweinitz (*Text-Book,* page 701) says, cycloplegia "may result from a lesion in the trunk of the oculomotor nerve or in the anterior part of its nucleus. Unilateral cycloplegia is said to be possible under the influence of disease of the ciliary ganglion. Paralysis of accommodation may be caused by affections of the nervous system, infectious diseases, and by intoxications. A very common cause of double paralysis of the ciliary muscle is diphtheria. Cycloplegia is also occasioned by spinal disease, by diabetes, by mumps, by tonsilitis, and frequently by acquired syphilis, and is often associated with paralysis of the sphincter of the iris. Inherited syphilis is a rare cause of paralysis of accommodation. Paresis of the ciliary muscle is common after certain fevers—for example, typhoid fever. Various ptomains, toxins, fish and meat-poisonings may cause both paresis and paralysis of the ciliary muscle."

Cycloplegic. This term is used as an *adjective* in the sense of referring to *cycloplegia* (q. v.). As a *noun* it is commonly employed to indicate those drugs that paralyze the ciliary muscle (muscle of accommodation). All cycloplegics are mydriatics, but mydriasis (partial mydriasis) may be produced by some drugs without cycloplegia.

Cycloplegia is produced by the use of a cycloplegic instilled between the lids. It has been experimentally proven that drugs instilled

into an eye which produce cycloplegia or mydriasis, act directly upon the nerve terminals in the ciliary body and iris through the medium of the aqueous humor. Aqueous humor drawn from the eye of an animal into which atropine had been instilled was found to contain the drug, and this drug-laden aqueous was instilled into another eye, the pupil of the eye thus treated becoming dilated.

The reason that certain drugs, such as cocaine and eupthalmin, produce mydriasis without causing cycloplegia, is because partial mydriasis may be produced by irritation of the sympathic nerves which results in dilatation, probably by its effect upon the vaso-constrictor fibres. It will be found that any drug which produces maximum mydriasis will produce cycloplegia, but in order to produce maximum mydriasis there must occur stimulation of the sympathetic and paralysis of the terminals of the third nerve, which controls both the sphincter pupillæ and ciliary muscle.

The various cycloplegics in common use differ in the degree of cycloplegia produced, and mainly in the length of time required before cycloplegia disappears. Certain preparations such as homatropine-hydrobromide or hydrochloride produce cycloplegia and mydriasis, which lasts from twelve to forty-eight hours, while a solution of atropine of which a single drop of 1 per cent. solution has been instilled will produce cycloplegia for from seven to ten days, and if it is used three times daily for two days, it may persist even longer. It is, therefore, obvious that while it may be admitted that such a preparation as atropine may produce more complete cycloplegia than those drugs having more transitory effect it is disadvantageous for routine refraction work because of its lasting effect. In cases of spasm of accommodation the instillation of the one or two per cent. solution of atropine three times a day for several days or longer may be required to produce the complete effect, and is more useful than homatropine solutions when it is desired to administer the so-called "rest treatment."

Any of the cycloplegic alkaloids may produce toxic symptoms, such as redness and dryness of the throat, flushed face, rapid pulse, vertigo, trembling of the extremities, erythema (which may extend over the whole body), syncope and death. The antidotes are morphine and pilocarpine administered hypodermically.

In addition to toxic symptoms atropine and some of the other cycloplegics occasionally give rise to a distressing and persistently increasing irritation of the conjunctiva and skin of the eyelids, which, if the use of the drug is persisted in, produce an edema and mucous discharge. The itching and discomfort resulting from this irrita-

tion may be so great that its further use has to be discontinued, in which case, sometimes but not always, it may be found that for the atropine and other drugs, hyoscine, duboisine, daturine, but preferably scopolamin may be substituted. Atropine and its salts, especially the sulphate, is the most used cycloplegic for the treatment of diseases of the eye, and is still very commonly used for the purpose of determining refractive conditions, though the salts of homatropine, owing to their more transitory effect, occupy a more favored position in this field.

To avoid the toxic effect of these drugs the finger should be pressed upon the canaliculi at the internal canthus for a few minutes after the instillation of the drug, thereby preventing, to a certain extent, the entrance of the drug into the nose and throat, from the mucous membrane of which absorption so readily takes place. In children where a cycloplegic has to be persistently used, atropine should be dissolved in some oily preparation such as castor oil or olive oil, as oils being thicker do not as readily pass through the lachrymal apparatus into the nose. It should be borne in mind that the salts of the cycloplegic alkaloids which are commonly used in aqueous solutions are not soluble in oils, and that when writing a prescription for an oily solution the alkaloid of atropine, or whatever preparation is used, should be specified. It is wise to emphasize this point upon the prescription as many drug stores do not have the alkaloid in stock. Or to prevent the entrance through the nasal duct the alkaloid may be used in the form of an ointment put up in vaseline. The use of these drugs in an oily vehicle has the further advantage that they remain longer in the conjunctival sac and therefore undergo a more extensive absorption, producing thereby a more permanent effect.

Cycloplegics are used to produce rest in the ciliary muscle for the purpose of reducing irritation in inflamed eyeballs, and also for the purpose of determining the refraction of the eye unmodified by ciliary activity.

Miotics, such as pilocarpine solutions in the strength of 1 per cent., such as pilocarpine muriate in water 1 per cent., or eserine sulphate in water 1/5 of 1 per cent. may be instilled into the eye to counteract the effect of a cycloplegic, but the action is too weak and transitory to be effective excepting in the case of the homatropine preparations, whose effects are more transitory than atropine.

When miotics are employed, they should be instilled frequently to secure the desired effect. In other words, miotics are only effec-

tive in counteracting the effects of cycloplegics when the cycloplegia has begun to subside.

The use of cycloplegics for refraction work: Atropine sulphate in distilled water, one or two per cent. solution, or atropine alkaloid in castor oil in from one-fourth of one per cent. to one per cent. solution, is ordinarily used for paralyzing accommodation, in young children or in the case of spasm of accommodation. In young children it will be found that one or two instillations may produce complete cycloplegia within an hour or two after its instillation, while it will be necessary to prescribe more continued use of the drug, in cases of spasm of accommodation. In such cases one drop should be instilled three times a day for two or three days, and in stubborn cases it may require several weeks to relieve the spasm.

Homatropine. In those cases where it is desirable to produce temporary cycloplegia (and this covers by far the vast majority of cases requiring refraction work) homatropine alkaloid or preferably homatropine hydrobromate is used and because of the fact that homatropine is somewhat irritating, and because cocaine facilitates absorption through the cornea, it is customary to instill first a 1 per cent. solution of hydrochlorate of cocaine and follow with a solution of hydrobromate of homatropine. In case of the solution, four grains in a half fluid ounce of distilled water is used. One drop is instilled into the eye to be examined every ten minutes for one hour, cycloplegia occurring in an hour and a half after the first drop has been instilled. This method is open to the objection that it has to be instilled frequently and produces in many patients an unpleasant taste and a dry throat.

Furthermore it will be found that more complete cycloplegia without this discomfort may be produced by the use of gelatine discs containing each 1/50th grain of *homatropine, cocaine hydrobromate,* used in accordance with the directions of Casey Wood. The writer has used the discs and method described below for twenty years, and believes it to be the most satisfactory for the production of transitory cycloplegia.

Casey Wood describes in his *System of Ophthalmic Therapeutics* (page 60) his method of using the gelatine discs, as follows: "Gelatine lamellæ or discs appear to be the most useful form in which to apply agents to the eye for the purpose of securing their fullest mydriatic and cycloplegic action. These undergo a slow, regular and complete absorption when put into the conjunctival sac.

"The addition of cocaine to almost all the alkaloids used in ophthalmic practice undoubtedly increases their peculiar effects.

"From the foregoing results and after much experimentation on the subject, I concluded that the most decided cycloplegic effects of homotropine are obtainable from its employment in the gelatine disc form, associated with cocaine.

"In their most convenient and stable shape these discs cannot be made to hold more than gr. 1/25 of these alkaloids; hence I was necessarily restricted to the use of gr. 1/50 each of Merck's homatropine and cocaine.

"Subsequently I experimented with the gelatine discs just described, with discs containing gr. 1/25 of homatropine alone, and with various solutions in water of tropa-cocaine, homatropine plus cocaine, duboisine sulphate, hyoscin hydrobromate and hyoscyamin sulphate.

"For the determination of the refractive condition and with the idea of making the conditions of the comparative test as constant as possible I chose those patients in whom I could employ a number of agents at proper intervals, and whose refractive state would be most likely to afford reliable tests. These were put under the influence of the particular cycloplegic and their refractive state determined by skiascopy. Every case was carefully worked out by T. A. Woodruff.

"As a result of these and other experiments I have reached the following conclusions, some of which are modifications of the propositions contained in my first article:

"1. If two gelatine discs containing gr. 1/50 each of homatropine plus cocaine be placed in the conjunctival sac at an interval of twenty minutes, the eyes being all the while kept closed, the ciliary muscle will in most instances be found to be fully paralyzed in from seventy to one hundred minutes after the introduction of the first disc.

"2. In persons under twenty-five years of age, or whenever ciliary spasm is suspected, the best results are obtained by the use in another twenty minutes of a third disc or one containing gr. 1/25 of homatropine alone, the examination in that case being best made between ninety and one hundred and twenty minutes after using the first disc. The first two discs containing cocaine are sufficient to furnish the chief advantage which, in my opinion, resides in the alkaloid, viz.: of increasing the absorbing powers of the cornea for agents combined with it, while the increased dose of homatropine produces a more thorough relaxation of the ciliary muscle.

"An eserine disc (gr. 1/1000) inserted the following morning will enable the patient to do near work within an hour or two.

"3. The discs should be inserted on the top of a damp, camel's-hair brush and should always be applied to the ocular conjunctiva at its inferior and outer surface, the patient looking up and in, while the lower lid is drawn down. Any adherent or sticky gelatine may be easily wiped off the palpebral edges with a damp cloth or a piece of wet absorbent cotton, before making the examination."

F. A. Morrison (Wood's *System of Ophthalmic Therapeutics,* p. 65) prefers the following mixture, instead of a solution or the gelatine discs, for the purpose of insuring prolonged contact of the cycloplegic with the eyeball: Cocain, hydrochlor., homatropin hydrobrom., aa. gr. iss; pulv. acaciæ, ʒii.

A little to be placed on the eyeball, or in the sac, near the outer canthus. Keep the eye closed.

John M. Robinson, of Duluth, Minn. (p. c.), has recently made attempts to test the *action of homatropin by sub-conjunctival injection.* He had in mind the idea of securing thereby a more exact dosage and effect than by any of the old methods, by locking up, beneath the conjunctiva, single definite amounts of this drug and—when they were to be compared—of other drugs, such as atropin. So far his experiments have been confined to a few (and insufficient) number of cases, but the results are given if for no other purpose than to draw attention to the method.

The cycloplegia from subconjunctival doses of homatropin (alkaloid) commences in from five to seven minutes after the injection is given. It reaches its maximum in from twenty-five to forty minutes; begins to pass off at the end of two hours, and the action of the ciliary muscle seems to be again normal at the end of twenty hours. The dose was gr. 1/100, dissolved in five minims of a one per cent. solution of cocain. To the solution of cocain, sterilized by boiling, was added the homatropin, after which the solution was again brought to the boiling point. In addition to the above single dose he has used the injections eight and, in some cases, nine times where he found it necessary to induce cycloplegia rapidly, as with patients who had to leave town by an early train, etc.

For purposes of comparison he injected the alkaloid beneath the conjunctiva of one eye in the dose and manner just described, and in the others introduced it by instillation only, when a drop of a two per cent. solution was instilled four times at ten-minute intervals, care being taken that it was retained in the conjunctival sac. He then found that full cycloplegia was attained ten minutes sooner in the injected eye, although it recovered its full function more rapidly than the other.

Beyond slight conjunctival hemorrhage patients suffered no inconvenience and no pain.

The writer feels that excepting in young children and in cases of accommodative spasm, homatropine used in accordance with the method of Casey Wood above described, is satisfactory for refraction work. Yet it must be admitted that some cases will develop more latent error by the use of atropine or some other more lasting cycloplegic.

To give an idea of the opinion of various authorities regarding the value of various cycloplegics, the following abstracts are appended.

Woodruff (*Ophthalmic Record*, 1909, p. 178) and Morrow (*Cleveland Med. Jour.*, March, 1909) advocate the use of cycloplegics in measuring the refraction. The former employs homatropin as a rule—1 to 40—frequently repeated. In strabismus, spasm of the accommodation, astigmatism against the rule and mixed astigmatism, he prefers atropin. Hill (*Ohio State Med. Jour.*, May 15, 1909) prefers scopolamin. Duane (*Arch. of Ophth.*, 1909, p. 512) finds that it usually takes about twenty-five minutes for the light reaction to be completely abolished after instillation of homatropin. The accommodation is usually affected before the pupil begins to dilate. Cocain enhances the rapidity to some extent, and the amount of dilatation, but not the degree of cycloplegia. Of 140 cases examined to test the efficacy of homatropin and cocain in refraction work up to the age of 16, Cruise (*Tr. Ophth. Soc. U. K.*, Vol. 29, p. 245, 1909) became convinced of the greater value of the former as a cycloplegic as compared with atropin. Scott (*Monthly Cyclopedia and Med. Bull.*, Aug., 1909) has found upon himself a slight mydriatic and cycloplegic action from instillations of a 4 per cent. solution of alypin. Two grains of alypin by the mouth, and again one grain hypodermically, caused complete paralysis of the accommodation of short duration and unaccompanied by mydriasis.

As the result of comparative measurements of the refraction under homatropin and atropin, Emerson (*Ophth. Record*, Vol. 19, p. 463, 1910) found practically no difference between the two agents. He recommends homatropin, 1 to 60, instilled every ten minutes for an hour (he adds cocain to the solution). He also recommends it for its therapeutic action in cases where a mild mydriatic is sufficient.

Scopolamin. Marlow (*Ophth. Review*, Vol. 30, p. 74, 1911) states that one instillation of 1/5 of 1 per cent. of scopolamin is an effective cycloplegic. The cycloplegia seems to be complete at the end of an hour or slightly more. In some special cases, 131 eyes, a second instillation was practised, or even a third. A study of these latter

cases has furnished an opportunity of determining the efficiency of a single application of the drug. His main conclusion from the above series of observations seems to be that in a large majority of cases one instillation of scopolamin is just as effective as two, and that even in those in which a second application effects a more complete cycloplegia, the change is very slight, usually a negligible quantity. The author admits that a disadvantage of scopolamin as compared with homatropin is that its effects take about three times as long to pass off; he thinks, however, that this is compensated by its greater certainty of producing complete cycloplegia as against homatropin, which he charges with not infrequent failure to produce complete relaxation of the ciliary muscle.

Hyoscin. Clarence M. Harris (*Ophth. Record,* Vol. 20, p. 743, 1911) uses one-tenth per cent. hyoscin with about one per cent. cocain hydrochlorid used in the same way, in all persons under forty years of age, who will submit to it, using homatropin in those between the ages of forty and fifty when indicated and in brief cycloplegia in those over twenty-five. Take Merck's hyoscin hydrobromid and triturate one grain of it with eight grains of cocain hydrochlorid. One-half grain of this is practically equivalent to one-sixteenth grain of hyoscin and one-half grain of cocain; this is weighed and placed in a clean vial. When prescribed, one dram of water is added, giving an absolutely fresh solution.

Alypin. Scott-Moncrieff (*Ophth. Review,* Feb., 1910, p. 60) finds that alypin used locally produces slight mydriasis and partial paralysis of accommodation but if exhibited by the mouth or by hypodermic injection it is a powerful cycloplegic. The paralysis of accommodation is complete, it comes on in a very short time, and passes off quickly, and the mydriasis produced is only very slight. These results lead Moncrieff to think that the drug may prove to be very valuable in the diagnosis of errors of refraction. Experiments performed at Cambridge (*British Med. Jour.,* March 27, 1909) seem to show that alypin is more toxic than cocaine, but in Moncrieff's experience this is entirely at variance with clinical observation. (*Indian Medical Gazette,* July, 1909.)

Duboisin. Santos Fernandez (*Anales de Oftalmologia,* Apr., 1912), of Havana, uses duboisin in preference to atropin. As regards mydriasis, and beneficent action on most of the inflammatory conditions of the eye, the properties of the two drugs are equal. But the toxic action of duboisin is less marked and less frequent than that of atropin. Hence he recommends duboisin especially in children, in pref-

erence to atropin, although the price of the former drug is a good deal higher than that of the latter.

When and how shall we use cycloplegics in refraction work? Duane (*N. Y. State Jour. of Med.*, July, 1908) replies to this question by the following conclusions, based on long practical experience and a special series of tests:

1. A cycloplegic should be employed for determining the refraction in practically all cases, not glaucomatous, below 48 years of age and in some cases above this limit.

2. Homatropin in 2 per cent. solution, provided it is used with ordinary precaution, is a safe cycloplegic, and if properly used is effective in the vast majority of cases.

3. It should be repeatedly instilled and the examination made not less than an hour after the first instillation, nor until a test of the accommodation has shown that the latter is as completely abolished as possible.

4. The cases in which homatropin proves inefficient are few. They are marked by varying vision and varying acceptances, discrepancies between the subjective tests and the skiascopic findings, and the persistence of an undue amount of accommodation (more than one D) even after prolonged action and repeated instillations.

5. In such cases atropin should be used.—(F. C. T.)

Cyclops. Rhinocephalus. A congenital malformation consisting in a fusion of the two eyes into one, the resulting organ, like that of the mythical giants from which this condition takes its name, being placed in the centre of the forehead.

The best account of the ocular relations of this monstrosity is given by Stephen Mayou (*Trans. Oph. Soc., U. K.*, Vol. XXVI, p. 267). He prefers the theory put forward by Dareste (*Annales d'Oculistique*, Vol. 106, p. 171) to explain the formation of cyclops, viz.: that it is maldevelopment of the anterior end of the neural tube during very early fetal life, the probable cause of which is deficient liquor amnii or intra-uterine inflammation.

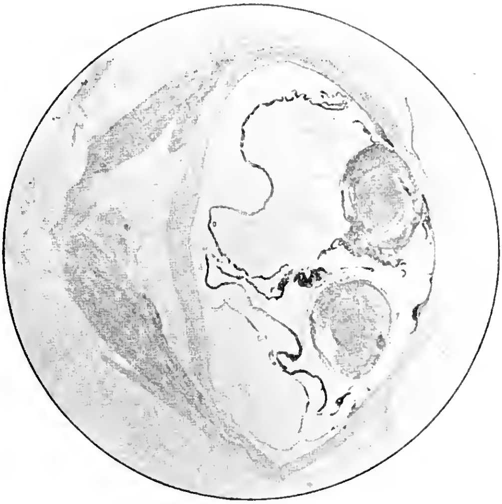
In one specimen described by the writer (see figures) the *eyebrows* were united at the median line; the *eyelids* were only partially developed and there were notches in fused upper lids. The *caruncle* was single and situated in the lower angle. Four puncta were present, two on each side, in the lower lid. There were no puncta in the upper lid. There was a fold of conjunctiva above the caruncle, probably representing the plica semilunaris. The optic nerves were single and arose from a process of brain which ran down to the optic foramen. No optic tracts could be made out. The rest of the cranial nerves

were double and in their normal position. There were two ophthalmic arteries passing through the foramen on either side of the nerve.

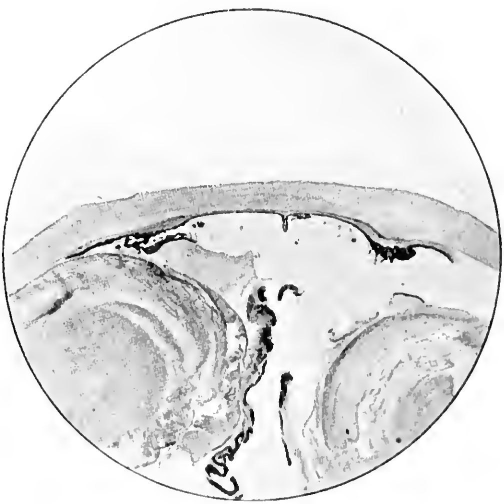
A Human Cyclops, Showing the Absence of a Probosis but Distinct Notching of The Upper Lids. (After Mayou.)

A Human Cyclops, Showing the Base of the Skull and Cranial Nerves (note the single optic nerve). (After Mayou.)

Roland (*Gaz. des Hôpitaux*, No. 6, 1908) has reported a case of cyclops in which there was complete fusion of the eyes in a single

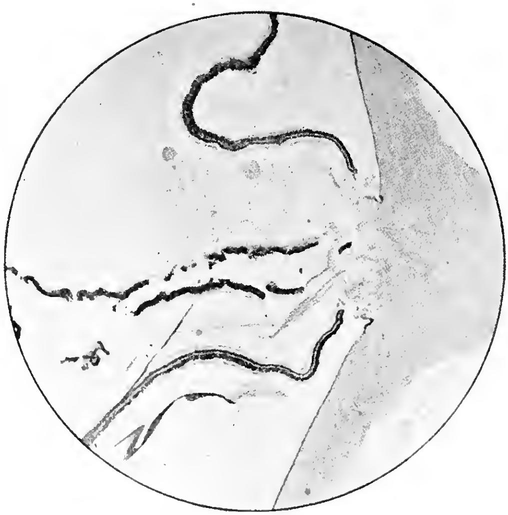


A Human Cyclops, Showing Two Primary and Secondary Optic Vesicles within One Globe. (After Mayou.)



A Human Cyclops, Showing the Process Formed by the Fusion of the Ciliary Bodies and the Foetal Condition of the Anterior Chamber. (After Mayou.)

median orbit, with absence of any nasal development. The healthy mother had borne two normal children, and there was no consanguinity or history of ocular defect in the family. Seefelder (Graefe's *Arch. f. Ophth.*, Vol. 68, No. 2, 1908) describes the findings in four cyclopic eyes. The question whether the embryonal ocular structures are single from the first, or become so through subsequent union, is not definitely determined; probably both conditions occur. As to the



A Human Cyclops, Showing the Disc with Two Retinal and Two Hyaloid Arteries. (After Mayou.)

ultimate causes of cyclopism, investigations are still less agreed. Mizuo (*Trans. 35th Ophth. Cong., Heidelberg,* 1908) also reports a case of cyclops with a single eye and single optic nerve.

Van Duyse (*Arch. d'Opht.,* 1909, p. 65) gives the microscopic findings in a case of cyclops with cryptophthalmos and cystic coloboma of slight degree. The cleft was united, only in the posterior segment of the globe. The globe was so hidden that the little differentiated corneal layers were invisible. The optic nerve groove contained no vessels. The retina was nourished by loops of vessels springing from the optic-nerve-stalk. There was an inferior coloboma.

Natanson, Sr., (*Klin. Monatsbl. f. Augenheilk.,* March, 1909, p. 343) reports a case of cyclops in a 7-months-old fetus. Beneath the proboscis there was a lip cleft of an oval rhomboid form. The lids were ciliated and there were two lower puncti lachrymali. The eye-

ball possessed two oblique corneas. There was typical inferior iris coloboma. Hydramnion with adherent placenta existed. Because of this, syphilis in the parents must be considered as a condition which may lead to hydrops.

De Vries (*Nederl. Tijds. Geneesk.*, I, p. 1426, 1908) also reports a case of cyclops.

Cyclops is also the name given to a genus of fresh-water crustaceans of the order Copepoda or "water-fleas." They have a single, median eye, that is generally bright crimson and sparkling like a jewel.

Cyclops-eye of Hering. In physiologic optics this is an imaginary eye supposed to be located midway between the two real eyes in the region of the root of the nose; in it the retinæ of the two eyes lie upon each other in such a manner that the corresponding points (q. v.) coincide. Hering used the idea of the cyclops-eye as illustration of his law of identical or corresponding points of the retinæ. In such an eye the line of direction of two coincident points would lie in the same line of sight.

Cyclorama. A circular panorama.

Cyclostat. An optical instrument for examining a rotating body in a state of apparent rest.

Cyclotome. An instrument invented by Guérin, of Bordeaux, for the extraction of cataract. It was composed of a ring of gold and a cutting blade, by means of which the eyeball could be fixed while the cornea was being cut; also knife for performing cyclotomy.

Cyclotomy. An operation for the relief of glaucoma, consisting of an incision through the ciliary body.

Cyclotropia. In the case of this oculomuscular defect there is an actual loss of parallelism between the vertical axes of the eyes and the fixed median plane of the head. This condition probably never exists alone, though it is often found in connection with other forms of heterotropia, as has been shown already. It may be, however, the chief condition in some cases, the lateral or vertical deviations of the visual axes being complications; but far more often the cyclotropia is a complication of the vertical and lateral deviations. There are two classes of cyclotropia, namely, similar and dissimilar. In the former class the cyclotropia is plus or minus in both eyes, while in the latter class the error is plus in one eye and minus in the other. The former might be termed "non-parallel cyclotropia"— that is, the vertical axes are either divergent or convergent; the latter might be termed "parallel cyclotropia"—that is, the vertical axes are inclined one toward, and the other from, the median plane. Cases of parallel cyclo-

tropia are not often found; and of the non-parallel class, plus cyclotropia is far more common than minus cyclotropia. In parallel cyclotropia, if the minus error is in the right eye and the superior oblique is the cause, in the sense of being too strong, the complication for that eye will be catatropia; but if the superior rectus is the cause, the complication will be hypertropia. The plus cyclotropia of the left eye will be complicated with hypertropia if the inferior oblique is the cause, and catatropia will be the complication if the inferior rectus is the cause. In esotropia, which may complicate parallel cyclotropia, the internus of the right eye, if attached too high, will aid in the production of the minus cyclotropia, and, in some cases, may be the chief cause of the minus cyclotropia; while the internus of the left eye, if its attachment is too low, will aid in the production of the left plus cyclotropia. A too low right externus would be a causative factor of the minus cyclotropia, and a too high left externus would help to cause the plus cyclotropia of this eye. In plus cyclotropia of both eyes, the error is caused by both inferior obliques or by both inferior recti. If the inferior obliques cause the error, the necessary complication will be double hypertropia; and if the inferior recti are the cause, the necessary complication will be double catatropia. The interni, with their attachments too low, can help the inferior recti in the development of plus cyclotropia; and the externi, with their attachments too high, can aid the inferior obliques in the causation of the plus cyclotropia.

Minus cyclotropia of both eyes can be caused by the superior obliques alone, when the complication will be double catatropia; it can also be caused by the superior recti, when the complication will be double hypertropia. Externi that are too low can help the superior obliques in the production of minus cyclotropia, and the interni that are too high can aid the superior recti in the production of minus cyclotropia. Plus cyclotropia of one eye, with hypertropia, is caused by the inferior oblique; plus cyclotropia of the other eye, with catatropia, is caused by the inferior rectus. Cyclotropia, of whatever kind, can be detected and measured by means of the cyclophorometer, used as in the investigation of cyclophoria. Because of the amblyopia that usually exists in one eye, the red glass should be placed in the cell behind the rod that is before the better eye. The prism of five degrees should be placed in the cell behind the rod that is in front of the amblyopic eye, base either up or down in the former position, if this eye is hypertropic; in the latter position, if it is catatropic. If

the red streak of light is below, and the two streaks converge at the ends corresponding to the red glass, there is plus cyclotropia; if they converge at the other ends, there is minus cyclotropia. Turning the rods in the directions that will parallel the streaks, and at the same time make them appear to be horizontal, measures the error; and the pointing of the index also names the error. If the two stand in the nasal quadrant, the error is plus; if they stand in the temporal quadrant, the error is minus. Cyclotropia, like the other forms of heterotropia, is alternating—that is, the fixing eye, whichever it may be, will have its vertical axis parallel with the median plane of the head, while the vertical axis of the other eye will be torted out or in, as the case may determine. It is also comitant, the angle being the same in all positions of the eyes. Cyclotropia, caused by paralysis, or paresis, and operations, is non-comitant, and will be attended by most annoying symptoms. The symptoms of comitant cyclotropia are those common to the other forms of comitant heterotropia, including the loss of vision in one eye, caused by mental suppression. Reflex symptoms are caused by nervous tension of the weaker oblique of the fixing eye, that the vertical axis may be made parallel with the median plane of the head. It is necessary to speak of the treatment of cyclotropia when it is the chief error; it rarely exists alone. If there is much plus cyclotropia, complicated by double hypertropia, but no marked lateral error exists, the operative effect should be equally divided between the two eyes. Either the two inferior obliques should be divided completely (for the reason that a partial division of these muscles seems impossible) with the Graefe knife; or a marginal tenotomy of both superior recti should be done, consisting of a division of the nasal and central fibres of each, leaving uncut the temporal fibres. The results of the operation on the superior recti would be the same in kind, if not in degree, as those done on the inferior obliques—namely, the two eyes would be partly, if not wholly, relieved of the outward torsion, and they would be relieved more or less of the double hypertropia. In the absence of any lateral deviation, the only remaining muscles to be subjected to operations are the inferior recti, whose nasal fibres should be shortened or advanced equally. The operations on the inferior recti would correct more or less of the plus cyclotropia and the double hypertropia. Plus cyclotropia complicated by hypertropia of the right eye and catatropia of the left eye, should be treated first by one or the other of two operations on the right eye—that is, either the inferior oblique should be cut, or a marginal partial tenotomy, including the nasal and central fibres, should be done on the superior rectus. Either of these operations would cor-

rect wholly or in part both the plus cyclotropia and the hypertropia of this eye. The next step would be to divide the temporal and central fibres of the inferior rectus of the left eye, which would correct wholly or in part both the plus cyclotropia and the catatropia of this eye. If, after these operations have been done, there should remain some of both the plus cyclotropia and the hypertropia of the right eye and catatropia of the left eye, one other operation should be done on each eye—namely, the nasal margin of the right inferior rectus and the temporal margin of the left superior rectus should be either shortened or advanced. Plus cyclotropia uncomplicated by any other deviation, should be relieved by either a nasal marginal tenotomy of both superior recti or by a nasal marginal advancement or shortening of both inferior recti; or, in cases demanding it, both operations should be done on each eye. Since a double catatropia would result, necessarily, from either marginal tenotomies of the superior recti or marginal shortenings or advancements of the inferior recti, the former operation should be preferred, for the reason that it is both more easily done and less annoying afterwards to the patient. In those cases in which subduction is greater than normal (more than three degrees), after the nasal marginal tenotomies of the superior recti have failed to correct the plus cyclotropia, temporal marginal tenotomies of the inferior recti should take the place of the nasal marginal shortenings or advancements. Minus cyclotropia complicated or uncomplicated is so rare that its treatment may be dismissed with the statement that the part of a superior or inferior rectus that should be cut for plus cyclotropia should be advanced or shortened for a minus cyclotropia, and the part of these muscles that should be advanced or shortened for a plus cyclotropia should be cut for a minus cyclotropia. The same holds true also as to operations that might be indicated on the lateral recti, when errors of these muscles complicate minus cyclotropia. The superior oblique has probably never been divided, nor should this be done, for a minus cyclotropia.—(G. C. S.)

Cydonia. QUINCE SEED. The seeds of *Cydonia vulgaris* contain much cydonin, (mucilage) amygdalin and fatty oil, a combination that eminently fits them for use as a soothing emulsion and vehicle for other remedies in collyria.

The mucilage of quince has long enjoyed a reputation for these purposes and will be found quite equal to mucilage of acacia and similar agents.

Cyla. (L.) CYLADES. The hollows sometimes seen beneath the eyelids; also a name for the lower eyelids.

Cylades. (L.) Cyla—the hollow spaces beneath the eyelids.

Cylicotomy. CYCLOTOMY. The operation of dividing the ciliary muscle.

Cylides. (L.) Another form of **Cylades.**

Cylinder. CYLINDRIC LENS. This glass is one which has one or both surfaces composed of segments of a cylinder, and is formed of a series of prisms placed side by side. The resulting convergent points of every individual series composing the row must make a line of convergence. Cylindric lenses may have any of the general forms of spheric lenses. If the series of prisms are arranged with their bases together, a convex cylindric lens is formed; if the prisms are placed with apices together, a concave cylindric lens will be made. The utmost refraction of a cylindric lens always occurs at right angles to its axis. It acts only in one plane. Rays passing through such a lens in the direction of its axis are not refracted, but pass through in straight lines. As regards rays passing opposite to its axis, the cylindric lens acts like a corresponding spheric lens.

The axis of a cylindric lens is opposite the meridian of greatest refraction. To find the axis, hold the lens so as to see through it a part of some straight line; then turn the lens in its own plane until the part of the line seen through it appears continuous with the parts of the line above and below, the axis being then parallel to this line.—(J. M. B.) See **Lens**; as well as **Refraction**; and **Physiological optics.**

Cylinder, Crossed. See **Crossed cylinder.**

Cylinders, Badal's colored. This is a modification of the Holmgren method of testing for color-blindness in which round objects are used instead of skeins of colored wools. See **Color sense and color blindness.**

Cylindraxe. (F.) Axis-cylinder.

Cylindrical diaphragm. In microscopy, an adjustable cylinder with diaphragms of variable apertures which are screwed underneath the object plate of a microscope, in the path of the luminous rays, whose number they limit.

Cylindrical lens. CYLINDER. A lens with one or two cylindrical surfaces.

Cylindrical transposition. A practical exposition of this rather abtruse subject is given by Norbourne Jenkins (*Ophthalmic Record*, Vol. 8, p. 15, 1899) who points out the difficulties that surround the solution of some of the problems involved. He believes that hitherto

there has been no well-defined rule of solution. The various and complex theorems proposed are as numerous as the optical mathematicians who state them; each of whom presents some combination of abtruse principles, the explanation of which is understood only by the exponent himself. The propositions presented below involve only a limited knowledge of addition and subtraction, and almost reduce cylindrical transposition to an axiom.

A convex cylindrical lens of a given focal distance, say one metre, and of a given axis, say 90°, is the equivalent in refractive power of a sphero-cylindrical lens composed of a convex spherical lens of an equal focal distance, one metre, combined with a concave cylindrical lens of the same focal distance, one metre, but with the axis at a right angle, 180°, to that of the original convex cylindrical lens. (See example No. 1.)

A concave cylindrical lens of a given focal distance, say one-half metre, and for a given axis, say 180°, is the equivalent in refractive power of a sphero-cylindrical lens composed of a concave spherical lens of an equal focal distance, one-half metre, combined with a convex cylindrical lens of the same focal distance one-half metre, but with the axis at a right angle, 90°, to that of the original concave cylindrical lens. (See example No. II.)

One component cylindrical lens of any given combination should be converted into a sphero-cylindrical lens, and the computation is based upon this result.

The following examples illustrate the transposition of combined and compound lenses:

No. I.—A convex cylindrical lens: + 1.00 C. axis 90° $\bigcirc$ 0.0 is equal to + 1.00 S. $\bigcirc$ — 1.00 C. axis 180°.

No. II.—A concave cylindrical lens: — 2.00 C. axis 180° $\bigcirc$ 0.0 is equal to + 2.00 C. axis 90° $\bigcirc$ — 2.00 S.

No. III.—A crossed cylindrical lens: + 1.37 C. axis 82° $\bigcirc$ — 1.75 C. axis 172° is equal to + 1.37 S., — 1.37 C. axis 172° and — 1.75 C. axis 172°, which equal + 1.37 S. $\bigcirc$ — 3.12 C. axis 172°.

No. IV.—A convexo-convex sphero-cylindrical lens: + 2.25 S. $\bigcirc$ + 1.62 C. axis 88° is equal to + 2.25 S., + 1.62 S. and — 1.62 C. axis 178°, which equal + 3.87 S. $\bigcirc$ — 1.62 C. axis 178°.

No. V.—A convexo-concave sphero-cylindrical lens: + 3.50 S. $\bigcirc$ — 1.25 C. axis 165° is equal to + 3.50 S., — 1.25 S. and + 1.25 C. axis 75°, which equal + 2.25 S. $\bigcirc$ + 1.25 C. axis 75°.

No. VI.—A concave-concave sphero-cylindrical lens: — 3.00 S. $\bigcirc$ — 1.50 C. axis 77° is equal to — 3.00 S., — 1.50 S. and + 1.50 C. axis 167°, which equal — 4.50 S. $\bigcirc$ + 1.50 C. axis 167°.

No. VII.—A "mixed" sphero-cylindrical lens: + 2.12 S. $\bigcirc$ — 3.37 C. axis 60° is equal to + 2.12 S., — 3.37 S. and + 3.37 C. axis 150°, which equal — 1.25 S. $\bigcirc$ + 3.37 C. axis 150°.

No. VIII.—A sphero-cylindrical meniscoid lens: — 2.00 S. $\bigcirc$ + 3.25 S. compounded with + 1.50 C. axis 75° is equal to — 2.00 S., + 3.25 S. + 1.50 S. and — 1.50 C. axis 165°, which equal + 2.75 S. $\bigcirc$ — 1.50 C. axis 165°.

No. IX.—A sphero-crossed cylindrical lens: + 5.00 S. compounded with + 2.00 C. axis 85° $\bigcirc$ — 6.00 C. axis 175° is equal to + 5.00 S., + 2.00 S., — 2.00 C. axis 175° and — 6.00 C. axis 175°, which equal + 7.00 S. $\bigcirc$ — 8.00 C. axis 175°.

No. X.—A quadro-meniscoid lens: + 3.25 S. compounded with + 2.00 C. axis 65° $\bigcirc$ — 2.25 S. compounded with — 1.75 C. axis 155° is equal to 3.25 S., + 2.00 S., — 2.00 C. axis 155°, — 2.25 S. and — 1.75 C. axis 155°, which equal + 3.00 S.— 3.75 C. axis 155°.

Cylindricity. Cylindrical form.

Cylindric lens. A lens having one cylindric surface and the other plane. Also called a *plano-cylindric lens.*

Cylindricule. A small cylinder.

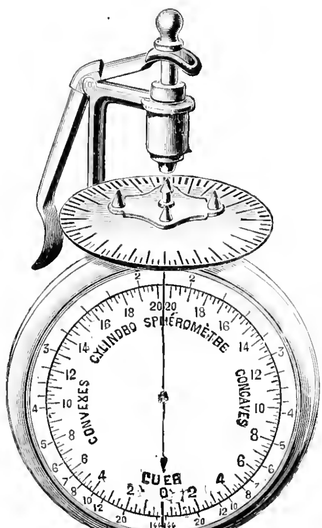
Cylindriform. Cylindrical.

Cylindroma. A form of epithelioma, chiefly of the caruncle, conjunctiva, eyelids, lachrymal gland, orbit, stomach and face, characterized by cellular proliferation in the lympathic net-work and the production of large cylindrical, clavate, or cactus-like hyaline bodies. According to Köster, it is the result of a secondary hyaline metamorphosis of cancroid; according to Ewetsky, it is either a plexiform sarcoma with colloid degeneration, or a proliferating myxomatous angeioma, or a mixture of the two.

According to the *Year-Book,* 1913, the tumor described by Duclos (*Ann. d'Ocul.,* Vol. 149, p. 445, 1912) under the name of cylindroma corresponds to the condition called by other writers tubular cancer, mucous chancroid, myxosarcoma, or alveolar epithelioma. In ophthalmologic literature it has been described by Van Duyse (*Soc. Belge d'Ophtal.,* Vol. 36, p. 62, 1912) as myelogenous endothelioma. Duclos' specimen had developed for four years along the margin of the lower lid in a man 39 years old at the time of operation. Recurrence was suspected a year after removal. Histologically the growth consisted of atypical epithelial masses invaded by bands of connective tissue most of which had undergone mucoid change.

J. H. Claiborne and E. L. Oatman (*Amer. Jour. Surg.,* March, 1911) have also described cylindroma of the orbit.

Cylindro-spherometer, Luer's. This is a three-point lens-measurer competent to indicate the strength of glasses ranging from 0 to 20 diopters. The axis of a cylinder is also indicated on the face of the instrument. See the figure.



Cylindro-Spherometer.

Cynoglossum officinale. (L.) GIPSY FLOWER. HOUND'S TONGUE. The whole of this plant is official. It furnishes a fixed oil, resin and gum; it is occasionally used as an anodyne, antispasmodic and demulcent. Beer (*Lehrbuch d. Augenkrankh.*, 1817, 2, p. 445) furnishes practically the only ophthalmic reference to this agent. A man with "diseased lungs," after taking full doses of the extract suffered from "amaurotic amblyopia."

Cyperus elegans. ANDRUE. GUINEA RUSH. ANTIEMETIC ROOT. The rhizome is the part used in medicine, for the checking of vomiting in various affections. The dose is 10 to 30 minims of the fluid extract. In Jamaica the infusion of this herb is used in cases of "amaurosis."

Cypress. *Cupressus sempervirens* was used by the ancients for caligo and ocular phlegmon. The juice of the fruit was generally employed, well mixed with oil. The leaves were also used as a local application.—(T. H. S.)

Cyprus-spurge. EUPHORBIA OFFICINARUM. WOLF'S-MILK. The juice of cyprus-spurge was employed, in the times of Pliny and Dioscorides,

as a remedy for cataract (hypochyma), amblyopia, and ulcers and scars of the cornea.—(T. H. S.)

Cyst. A tumor consisting of a cavity which has fluid, or partially fluid, contents surrounded by a capsule. See **Cysts, Ocular.**

Cyst, Choroidal. Cysts may occur in the choroid, but their presence is of extremely rare occurrence, and there is but scant mention of them in literature. Follin (*Bull. de la Soc. de Chirurgie,* ii, 1861) described a dermoid which, however, was not in the choroid proper, but between that tissue and the retina. It was composed of dense connective tissue with fat cells, covered with epithelium containing hair follicles and hairs on the outer side.

Cystectomy. Excision of a sac or cyst, generally of the lachrymal sac.

Cystein reaction. A biochemical test discovered in 1910 by Arnold. It is used, among other purposes, for differentiating the mature from the immature fibres in senile cataract. See Vol. III, page 1583, of this *Encyclopedia.*

Cysten des Ciliarkörpers. (G.) Cysts of the ciliary body.

Cyst formation in the lid. Occurring in connection with congenital microphthalmos this tumor is rarely encountered, the cyst in this condition being generally located in the orbit. Orloff (*Ann. d'Oculistique,* CXLV, p. 177, 1911) has published a comprehensive paper on the pathogenesis and anatomy of congenital microphthalmos with palpebral cyst, giving the various theories that have been advanced as to its causation. He believes with Pagenstecher, that circulatory toxins are probably the cause of the anomaly.

A serous cyst of the lid of unusually large size was reported by Alt (*Amer. Jour. Ophth.,* XXIX, p. 363, 1913). A little more than the nasal half of the right lower lid to the very caruncle and including the lachrymal canaliculus was replaced by the cyst. It extended to the conjunctival fornix on the inner, and somewhat below the tarsal tissue on the outer surface. Its highest part was raised about four millimetres above the normal lid margin and covered part of the pupil on the nasal side.

After removal by an incision through the skin surface at its lowest margin, a thin yellowish fluid escaped which showed no form elements whatever. A very small nodule at the edge of the lid, like a small stye, remained after the healing of the wound.

Cystic cataract. See **Cataract, Morgagnian.**

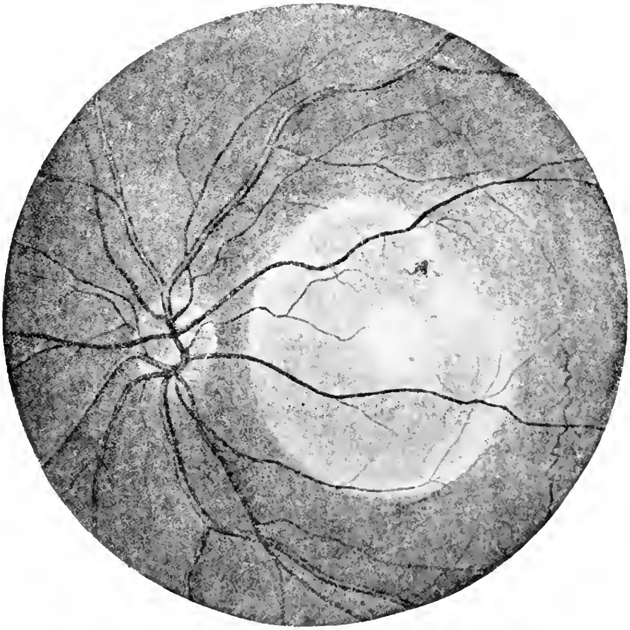
Cysticercus cellulosæ. The cysticercus or bladder-worm is in fact the immature form, scolex or larval stage, of a tapeworm, appearing as a rounded, fluid-filled sac. It occurs imbedded in tissue, being an inactive or resting stage in the life history of the organism. In this

stage it undergoes not only internal changes connected with the growth of organs, but also a radical increase in size which modifies greatly its external appearance and which is the primary reason for its pathogenic significance, so far as its own host is concerned. The number of species is large and their differentiation by no means a simple matter, but in the human host only one species is positively known. The few doubtful cases are attributable to malformed individuals of this species or to the very exceptional occurrence of some other form; neither of these possibilities affect the eye in which has been recorded thus far only the cysticercus of the common pork tapeworm of man, *Tænia solium*. For a comparison of the adult with other species see heading of **Ocular parasites.**

The larval form, known technically as *Cysticercus cellulosæ*, occurs usually in the pig, where it produces the condition known as "measles" and familiar to man from the most ancient times. The infection of man is brought about by the chance swallowing of mature eggs of this species which are relieved of their shells by gastric digestion so that the enclosed embryo is set free in the stomach. It is a minute, spherical mass, only about 20 μ in diameter, provided with six long, slender hooks, arrayed in three pairs. By means of these it is enabled to penetrate the alimentary wall and, assisted by the blood or lymph stream, to reach locations in which it settles down in the connective tissue for growth. While the number of cases on record is very large in which its location has been in the eye, yet this is not its usual seat. In 2,188 autopsies made in regions where the parasite is frequent the bladder-worm was found 2,141 times in subcutaneous or intermuscular connective tissue and never in the eye. Since its influence is due purely to pressure, its presence will remain unnoted and unimportant unless the position affects delicate organs or disturbs highly specialized functions. Vosgien enumerates 907 clinical cases in man; other records raise this to about one thousand in all. In over one hundred the infection was general, and of the 850 cases in which a localized infection was recorded the eye harbored about 47 per cent., and the nervous system over 40 per cent. more, while only 10 per cent. were reported from the connective tissues. This feature is easily explained by the clinical insignificance of the latter cases and the extreme importance of the former.

After finding a fixed location the hexacanth embryo discards its hooks and enters upon a period of growth in which one notes, first, the formation of a central hollow, second, a radical increase in size with accumulation of fluid in the central cavity, and third the ingrowth of a knob from the wall into the cavity. This knob transforms itself

gradually into an inverted tapeworm head which experimentally can be forced to evert when the bladder is relieved of external pressure, and then displays the suckers and hooks characteristic of the adult tapeworm. Though formed in reverse position it is in fact the head or scolex which, introduced into the alimentary canal, grows in length, forming numerous links or proglottids in longitudinal series and thus producing the full-grown parasite.



I. Subretinal Cysticercus, as Seen by the Ophthalmoscope, February, 1910.

In this species the hooks, 24 to 32 in number, form a double crown and measure 160 μ and 120 μ in length in the two rows. A stage so far advanced will rarely if ever come to the attention of the ophthalmologist, for such a form measures at least 6 to 8, rarely 10 to 20 mm. in diameter, and long before it has attained such a size the ocular disturbances have revealed its presence and demanded its removal.

The bladder has a translucent wall and a fluid-filled cavity before the head is formed and is ordinarily spherical or slightly ovoid, adapting itself readily to the pressure of adjacent parts. Hirschberg has called attention to the fact that in the vitreous body it often assumes the form of an oyster extending along the retina to which it usually adheres. Its form varies from day to day and for an account of its

characteristic movements we are indebted to descriptions of them as observed with the ophthalmoscope as also for accounts of cysticerci moving freely about in the anterior chamber.

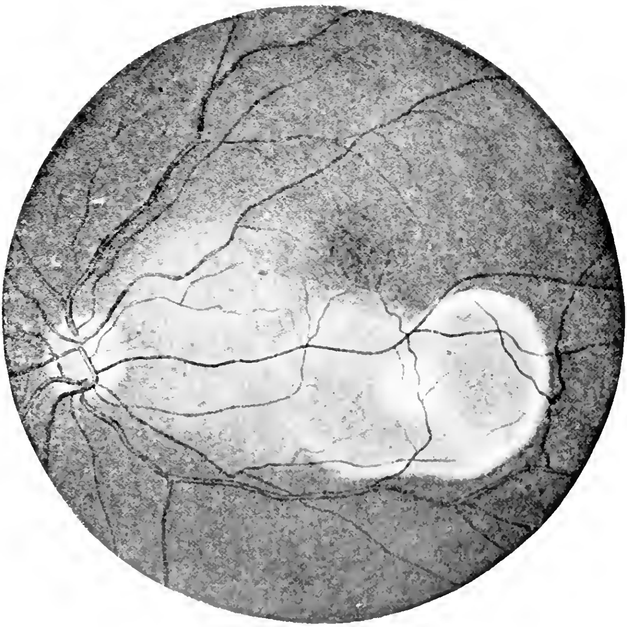
While multiple infection is the rule with the connective tissue form, where up to 3,000 cysts have been recorded in a single postmortem, it is only rarely that more than a single cysticercus has been discovered in the eye. Berger has recorded a case in which both eyes were infected; and Hirschberg described a recurrence of the parasite in the same eye after the removal of the first cyst. Two cysticerci in a single eye are reported by Kanweki, Dufour, and Alfred Graefe, and several by Sourow and Schobl. Yet there is no evidence at hand regarding the number of cysts elsewhere in the same subject.

The cyst wall which is formed around the parasite by the activity of the host organism appears to be wanting in cerebral and ocular cysticerci, and the abnormal or modified forms which they manifest may readily be the result of this freedom. The other abnormalities, recorded for *Cysticercus cellulosæ*, viz., three rows of hooks (var. *acanthotrias*) and absence of hooks (var. *anacanthina*) can not be determined in the early stages with which the ophthalmologist is concerned except that such might occur in orbital cysts, where Pascheff has found a specimen that had undergone calcareous degeneration. This is usually interpreted as a sign of senescence and does not occur in very young cysts. The spreading, oyster-shaped bladder-worm on the retina is in reality an early stage in the growth of the racemose or botryoidal form which develops often in the ventricles of the brain but does not rest undisturbed in the cavity of the eye long enough to attain that stage.

The presence of the adult parasite in man has been recorded from every section of the world. The larva also is on record from the human host in every region, but with great differences in frequency. The bladder-worm is common in man in Europe and rare in North America. The infrequency of its recorded occurrence in Asia, Africa and South America may be explained on the basis of scanty observations as readily as of scarcity of the parasite although the number of cases in Germany has decreased markedly since the introduction of the system of thorough examination of meat. Virchow records the decrease in the occurrence of *Tænia solium* from 1.6 per cent. of cases at the Pathological Institute, Berlin, in 1875, to 0.5 per cent. in 1882, and 0.16 per cent. in 1903. The same tendency appears in the records of eye infection during this period. Vosgien cites statistics as follows: middle of nineteenth century, 3 per cent.; von Graefe, 1853 to 1866, 90 cases in 80,000, or 0.112 per cent.; Hirschberg, 1869

to 1885, 70 cases in 6,000, or 0.116 per cent.; 1886 to 1894, 3 cases in 73,000, or 0.03 per cent.; 1894 to 1904, one case in 65,000, or 0.0015 per cent.; Uhthoff, before 1888, 0.099 per cent.; after 1888, in Berlin and Breslau, 0.004 per cent.; H. Cohn, before 1890, 0.44 per cent.; after 1890, none.

In Austria, Arlt has encountered only four cysticerci in 10,000 eye cases; in Denmark, Guit has one case in 70,000; in Belgium,



II. Subretinal Cysticercus, Same as the Previous Picture but After Displacement Operation.

Gallemaerts has five in 75,000; in Switzerland, Dufour and Horner reported four in 60,000; in England, Griffith reported one in 36,000 cases; in France, Dupuy-Dutemps found one in 160,000 cases at Paris and Dor one in 20,000 at Lyons, while in Bordeaux, Limoges, they "are not rare" (Vosgien). In Italy the parasite is much more abundant, de Vincentiis having recorded seven cases in 1886, and seven again in 1888. Records from other countries are not adequate to determine more than its presence. The large number of cases reported in Germany is due in part at least to perfection of diagnosis, to the prevalence of well-equipped clinics, and to their utilization by the people generally. The tapeworm is common enough in eastern and

southeastern Europe to produce ocular infections more numerous than reported from that region. On the other hand the extreme rarity of the eye cases in North America goes hand in hand with the infrequence of the adult parasite. Despite statements to the contrary by nearly all European authorities, the pork tapeworm is exceedingly rare in the United States. Both Stiles and I have commented on this repeatedly but the error still persists, probably because the breeding of pigs is carried on so widely in this country. Statistics of the Bureau of Animal Industry demonstrate also the infrequence of the cysticercus in the hog here. So far as eye cases are concerned, I have records of four only.

It is interesting to note that in many cases in which the cysticercus has been demonstrated the same person served as host for the adult parasite also; the degree of coincidence for the ocular cases is 12 per cent. To this must be added a not inconsiderable number of cases in which it was shown that some person closely associated (wife, husband, parent, sister, caretaker) with the host, carried the adult *Tænia solium*. These facts indicate clearly the probable occurrence of auto-infection and the ease of infection by contamination. The latter takes place *per os* by the eggs discharged with excrement and carried on dirty hands, clothing or utensils; the former may be attributed to reversed peristalsis which conveys ripe proglottids or eggs from the intestine into the stomach, releases the embryos from the shell by gastric digestion, and thus enables them to enter the tissues of the host that harbors the adult, without passing through any stage whatever in the outer world. This is not a purely hypothetical condition for at least three cases are reported in which a patient harboring a cysticercus has vomited proglottids of the adult tapeworm. Inoculation appears also to be related to injuries and may become localized at the point of a traumatism or possibly the embryo may secure admission to the tissues at such places. Brière reports that the eye of his patient was pierced by a plant spine; two months later a small elevation appeared on the surface of the conjunctiva and at the end of a month he removed a cysticercus. The evidence is imperfect and unsatisfactory; it suggests a rigid inquiry into the possibility of confusing some minute vesicular growth with the cysticercus, and the frequency of this acknowledged error among the cases now on record as bladder-worms.

Age seems to play a part in the infection of man, for in ocular cases the number is largest in the early decades of life and almost nil after 50 years. Perhaps this is traceable to the hygienic indifference of the infant, but such an explanation hardly applies to the

period from 20 to 30 years of age which shows the maximum infection of all periods. Still less easily explained is the predilection for certain localities at certain ages; two-thirds of the cases in which the cyst was attached to the conjunctiva fall between one and ten years of age and 64 per cent. of cases of ocular cysticercus concern hosts of ten to twenty years of age.

Von Graefe saw bladder-worms in an eye for four years, and Saemisch followed the growth of one for ten years. The latter records that in 1865 he saw in Paris a patient who had been accustomed for a long time to display a parasite at ophthalmologic clinics for a fee of 50 centimes per student. Zulzer states that a woman at Breslau showed an ocular cysticercus for twenty years. In most cases the location and growth would necessitate interference with the parasite before any such period had elapsed.

The exact location of the bladder-worm is tabulated by Vosgien for 907 cases. Of these only 807 were localized and 372, or 46 per cent., occurred in the eye. They were distributed as follows:

Retina	120 cases	32 per cent.
Vitreous body	112 cases	30 per cent.
Sub-conjunctival	84 cases	23 per cent.
Anterior chamber	26 cases	7 per cent.
Orbit	19 cases	5 per cent.
Iris	7 cases	2 per cent.
Lens	2 cases	½ per cent.
Cornea	2 cases	½ per cent.
Total	372 cases	100 per cent.

On the question of location Hirschberg says it is difficult to explain the preference of the cysticercus in France for the conjunctiva, in England for the posterior chamber, and in northern Germany for the deeper regions of the eye. One may suggest in reply that the number of cases is not very large, the age of the patients is somewhat different and the frequency and accuracy of examination and diagnosis is very unequal. Despite these facts the difference is certainly striking. Blanchard regards the free cysticerci as having escaped from a delicate cyst by rupture due to pressure during growth, which, if true, would mark them as cases of belated diagnosis rather than necessarily of different location from the cysts attached to deeper parts of the eye. In fact von Graefe and others are convinced by their studies of the organism by the ophthalmoscope that it is lodged originally behind the retina and perforates that nervous layer in order to attain the vitreous body. De Wecker and Jaeger

have illustrated the parasite in retro-retinal location with circular orifices in the retina through which they observed it pass into the vitreous body. These observations have been confirmed by various later workers with the ophthalmoscope, among whom may be noted Haase, Leber, and Scimini.

The *symptoms* are said to have no diagnostic value, and simply to be those of amblyopia. They are discussed in great detail by various authors, especially those who made observations on the living parasite and its movements. While most cases agree on the serious character of the condition, one case reported by Saemisch gave no trouble during ten years.

The first operation for the removal of a cysticercus in the vitreous was tried by von Graefe in 1855 with complete success; in 1858 and again in 1868 he modified and simplified his method. Later A. Graefe and Leber perfected the method, the former employing it successfully for bladder-worms near the posterior pole of the eye. A. Graefe also discussed the greater difficulties of operating where the cysticercus floated free in the vitreous body. All ophthalmologists appear to agree in recommending operative procedure at the earliest possible date, if the eyesight is to be preserved.

Sub-conjunctival cysticercus, which is relatively not uncommon, is treated by a much simpler operation and is without complications. Cysticercus of the orbit has a very different character, as the parasite is involved in a veritable fibroma that may attain considerable dimensions, reaching 22 mm. (von Graefe's case) or even the size of a date (Badal's case). The other rare conditions presented by cysticercus in the eyelid, cornea, lens, or on the iris, call for no special comment.

Among the more than 400 cases of ocular cysticercus on record only four are reported from the United States. The first was described in 1874 by Reynolds (*Amer. Practitioner,* p. 336) and the parasite was located on the pupillary margin of the iris. The second, by Turnbull in 1880 (*Cin. Med. News,* v. 9, p. 73), and the third by Minor in 1884 (*N. Y. Med. Rec.,* v. 26), both were found in the vitreous body. In all probability this form, to which European scientists, especially in Germany and Italy, have devoted so much attention, will continue to be fortunately one of the great rarities of ophthalmological experience in North America.

The best record of an American case of *cysticercus iridis* is that of Rembe (*Ophthalmic Record,* Vol. 16, p. 2, 1907). The patient, a boy of 7 years of age, without any significant previous symptoms, was found to be suffering from an inflamed eye which became steadily worse. On examination of the right eye a tumefaction was

noticeable in the anterior chamber along the lower half of the iris. Its apex corresponded to the vertical axis and it extended to within 1.5 mm. of the pupillary margin. It was some 4 mm. wide and 3 mm. high at the center and seemed to be intimately connected with the iris, being clearly surrounded by its anterior layer. The upper part of the cyst was transparent, whereas the lower portion contained a yellowish body. The color of the iris near the tumor was changed from reddish to bluish and at the constricted region of the cyst the latter was crossed by radial bands, the stromal layer of the iris. Most striking were the leech-like movements of the cyst, progressing in a lateral direction from the cephalic end. No noteworthy subjective symptoms were present in the patient. The stage of acute iritis due to the initial reaction of invasion by the parasite, which probably had taken place through the blood-vessels of the iris, was waning, and two weeks later the inflammatory condition had almost entirely disappeared. The case was operated on at this time, as most favorable before the stage of terminal reaction, which would have resulted undoubtedly in the destruction of the organ. After proceeding as in an ordinary iridectomy and allowing the aqueous humor to escape, the cyst wall was grasped through the incision by a capsule pincette and an effort made to extract the cyst *in toto,* but it tore and had to be removed piecemeal. The posterior portion of the cyst wall was adherent to the iris and could only have been removed by iridectomy, so that the small fragments were picked off as far as possible and the remnant left without sacrificing the iris. Recovery was uneventful. The shreds of the cyst wall left behind were quickly absorbed and the eye regained practically normal vision. The boy had no visible signs of other cysticerci on the surface of the body and showed no evidences that he was the host of a tapeworm. However, in the town from which he came, Niles Center, Illinois, one physician reported twenty cases of tapeworm treated in his own private practice within this same year. The illustration demonstrates admirably the appearance of the parasite. —(H. B. W.)

The *Ophthalmic Year-Book* gives interesting abstracts of the principal published cases of ocular cysticercus occurring (especially in Europe) during the last few years. They are as follows:

In Von Imre's case (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 531, 1910) there was a pear-like cyst at the caruncle. It proved to be a cysticercus *(Tænia saginata).*

Dupuy-Dutemps (*Ann. d'Ocul.*, Vol. 144, p. 305, 1910) saw a case of subretinal cysticercus in the right eye of a baker 35 years of age.

The parasite was plainly visible ophthalmoscopically between the disk and the macula and was seen to move about. Treatment with male fern was without effect. Pascheff (*Archiv. d'Ophtal.,* Vol. 30, p. 582, 1910) observed four cases of intraocular cysticercus. In the first, the parasite was under the retina in the macular region; in the second, in the retina; in the third, in front of the retina, and in the fourth, non-encysted in the vitreous. He practiced extraction through a meridional scleral incision. Barck (*Amer. Jour. Ophth.,* Vol. 27, p. 305, 1910) observed two cases of intraocular cysticercus, the first about twenty-five years ago. The parasite was free in the vitreous. Attempts at extraction failed and the eye was lost through chronic iridocyclitis. In the second case there was a history of a blow on the eye followed by a detachment of the retina. Later the head and neck of the scolex could be distinguished. Still later a second scolex was noted. Dianoux (*La Clin. Ophtal.,* Vol. 16, p. 1, 1910) treated a case of cysticercus of the vitreous with male fern. One hundred and two gm. of the ethereal extract was given over a course of seventy-one days. At the end of that time the retina was cicatricial and vascular at the site of the vesicle, and there was a proliferation of the retina in the vicinity. There was present also a subcutaneous cysticercus over the scapula.

Cerise and Monthus (*Soc. d'Opht. de Paris,* June, 1908) reported a case of intraocular cysticercus in which failure of vision had begun five months before the patient was first examined. There was clouding of the vitreous and a bluish-white area, looking like a detachment of the retina. Vision was already reduced to counting fingers. Six months later the development of a vesicle, and later a second smaller vesicle, clearly hemispheric, seemed to establish the diagnosis of cysticercus. Lépine (*Westnik Oftalmol.,* Jan., 1908) found that among 610,000 patients, seen at five of the principal Russian clinics, there occurred but six cases of cysticercus. He reports a case occurring in a man of 52, known for two years to have a tapeworm. A vesicle of 8 or 9 mm. in diameter was found in the vitreous, half covered with detached retina, and without increased intraocular tension. A meridional incision was made, starting 9 mm. back from the limbus, 5 mm. external to the superior rectus, and 8 to 9 mm. in length. And through this the vesicle was extracted. The detachment of the retina did not diminish, vision was not restored, but the eye remained quiet. Strachow (*Klin. Monatsbl. f. Augenheilk.,* Jan., 1908, p. 101) reports a case of extraction of a cysticercus from the region of the macula where it had caused hemorrhage. After the removal vision, counting fingers, improved from one and one-

half metres to four metres. In the macula there remained a pigmented scar. Blagowjestschenski (*Klin. Monatsbl. f. Augenheilk.*, Jan., 1908, p. 101) also reports a case of extraction of cysticercus from the region of the macula. The eyeball was preserved but with detached retina and divergence.

Bocchi (*Zeitschr. f. Augenheilk.*, Jan. 1908, p. 75) reports a case of cysticercus in which the parasite was swimming freely in the fluid vitreous. It was killed by an injection of sublimate solution, to avoid loss of vitreous in the process of extraction. Only 2 or 3 drops of vitreous escaped. There was no reaction, and the tension of the eyeball was normal in three hours. Dor (*Arch. d'Ophtal.*, Sept., 1908) reports a case in which the diagnosis of detachment of the retina had been made by several oculists. After treatment for this, by rest in bed, diminution of the detachment revealed a hemispherical cyst, in the lower temporal periphery of the fundus where it could be well illuminated by an electric lamp. A scleral incision was made with a Graefe knife, between the external and inferior recti muscles, and the point of the knife carried into the cyst. An intraocular needle for electrolysis attached to the positive pole was introduced within the cyst; and the negative electrode applied between the shoulders. The current was gradually increased, up to five milliamperes, at which strength it was continued for five minutes and then gradually decreased. Immediately afterward the patient declared he could see in all directions and the field of vision appeared to be restored. He was kept in bed twelve days and recovered good vision, which continued six months afterward. Cases of cysticercus have also been reported by Lodato (*Ophth. Review*, Sept., 1908), Schmidt-Rimpler (*Münch. Med. Woch.*, Vol. 55, p. 873, 1908) and Strakhoff (*Med. Obozr. Mosk.*, Vol. 69, p. 236, 1908).

In Pascheff's case of orbital cysticercus (*Arch. d'Ophtal.*, Aug., 1908) the post-bulbar cyst was filled with fluid and calcified; the outer wall was rich in eosinophiles and follicles—unique findings.

Pascheff (*Arch. d'Ophtal.*, Vol. 30, p. 582, 1910) also reported a case of bilateral papillitis in a case of cysticercus of the medulla. The interesting features were pain in the occiput, position of the head (held forward), double optic neuritis, vomiting and cardiac phenomena due to compression of the glosso-pharyngeal and pneumogastric nerves, and death from respiratory paralysis.

Judin (*Klin. Monatsbl. f. Augenheilk.*, Aug., 1909, p. 183) saw a subretinal cysticercus in the right eye of a farmer 27 years of age. Enucleation was refused. Two years later there was phthisis bulbi, and the patient consented to the removal of the eye because of pain.

The globe contained a homogeneous formation, with calcification and ossification; and a *fibrous* capsule, probably the dead cysticercus.

Two years after a broken glass injury to the conjunctiva, Elliot and Ingram (*Ind. Med. Gaz.,* June, 1911, p. 215) saw a subconjunctival cysticercus cellulosæ, in a 20-year-old French Eurasian. The cyst was easily extracted, and on section was shown to be a typical cysticercus of tænia solium. The authors raise the question as to whether the ova of the parasite were introduced by the broken glass particles, or whether they had been lying dormant and became active immediately after the injury. Wicherkiewicz (*Klin. Monatsbl. f. Augenheilk.,* Oct., 1911, p. 524) details three cases of intraocular cysticercus, the first being imbedded between the sclerotic and choroid, the other two in the vitreous. Extraction was successful in all three, but serviceable vision resulted in but two. In view of the generally unfavorable prognosis of the operative treatment Wicherkiewicz tried to kill the cysticercus by electrolysis as recommended by Dor. But neither electrolysis nor injections of Lugol's solution, nor fibrolysin had any effect. The author therefore concludes that extraction is the only expedient, as even if the parasite should be killed it retains the qualities of an intraocular foreign body.

Gallemaerts (*Arch. d'Ophtal.,* Vol. 32, p. 137, 1911) removed a cysticercus through a scleral incision in the case of a butcher. Later a second one developed, and on attempting the same scleral incision severe hemorrhage ensued. Electrolysis (5 milliamperes for five minutes) was then resorted to, and the parasite evidently killed, as the eye quieted down and light perception was preserved. In a second case Gallemaerts diagnosed cysticercus in a blind eye, on the basis of a marked eosinophilia. As in the preceding case, scleral incision was first tried and electrolysis afterward but after three weeks it became necessary to enucleate the eye. The author resorts to the following method of exploring the interior of the eye. The pupil having been well dilated, a glass slide with a concavity in the centre is pressed on the cornea. If a little sterile serum is floated between the two surfaces he claims that the interior of the globe can be readily seen.

Balbuena (*Arch. de Oft.,* Vol. 11, p. 250, 1911) studied a subretinal cysticercus in the region of the macula in an 18-year-old girl. The diagnosis was confirmed by the expulsion per rectum of a tænia. Operation being refused, pelleterine was used subconjunctivally three or four times without avail. Eight months later the patient returned with marked inflammatory symptoms and the eye was enucleated, revealing an encysted cysticercus.

Cirincione (*Arch. of Ophth.,* Vol. 40, p. 163, 1911) after study of the beginning intraocular changes in cysticercus believes that the effect upon the retina and optic nerve is an irritating one, giving rise to a preretinal cellular membrane. Contraction of the membrane produces contraction of the inner layers of the retina, throwing the latter into waves or folds and producing detachment. The small spots which lie in front of the cysticercus (pre-vesicular spots) are caused by subhyaloid cell nests. Extraction of a cysticercus from the vitreous is favorable only when the pre-vesicular spots are seen, in which case the sub-hyaloid space must be reached without opening the hyaloid membrane. The pathology of cysticercus as found by Re (*Ophthalmoscope,* Vol. 18, p. 513, 1911) presents essentially the characteristics of the usual inflammatory reaction with the formation of granulation tissue, giant cells, eosinophilia and plasma cells.

Finally, Wittich (*Klin. Monatsbl. f. Augenheilk.,* Nov., 1912) examined an eye microscopically which had been enucleated for malignant growth, and found a cysticercus. The parasite was in the retina itself, and had most likely been carried thither by the arteria centralis. The changes in the eyeball were limited to a small area, as an *enucleation* was done relatively early, and it was this which made the histologic examination of interest. There was a large number of eosinophiles in the connective tissue capsule and in the immediate vicinity of the parasite.

Cysticercus in the orbit. This is a rare occurrence in the tissue of the orbit, and has been described under the heading **Cysticercus.**

Cysticerque ladrique. (F.) Cysticercus cellulosæ.

Cyst in the anterior chamber. There is recorded in literature a very small number of instances of cysts, freely movable, in the anterior chamber. Fuchs and Businelli have mentioned them. Cases of easily movable pigment corpuscles in the anterior chamber have been described by Streatfield, Bock, and Apetz. Anatomical examinations of such a cyst or pigment corpuscle have been made by different observers, who have been able to differentiate two groups: in one, the freely moving pigment corpuscles, consisting of uveal pigment, and the second, in which pigmentous connective tissue could be seen. This accounts for the source of these formations, inasmuch as they develop either from loosened melanomes on the edge of iris, or else it is a fibrous thread that separates itself as a remainder of a persisting pupillary membrane, and sinks down to the bottom of the anterior chamber.

Denig (*Ophth. Record,* May, 1902) reported the case of a small, freely-moving cyst in the anterior chamber. It gravitated to the

lowest part of the chamber in whatever position the head was placed. The walls of the cyst were of a brownish-red color, and its contents translucent. With the aid of the binocular loup the iris beyond could be plainly seen. In the anterior lens capsule, on the upper and outer edge of the pupil, there was a whitish, triangular film; at the same place a posterior synechia could be made out. There was no visible evidence of a persisting pupillary membrane. The patient did not remember to have even had an inflammation in this eye.

Clausnitzer (*Klin. Monatsbl. f. Augenh.*, July, 1911) observed an epithelial cyst of the anterior chamber, caused by a perforating injury of the cornea three years previously. It was formed by a sinking in of the corneal epithelium. The anatomy of cysts of the cornea and anterior chamber is discussed quite fully by this same observer, in another paper (*Klin. Monatsbl. f. Augenh.*, Oct., 1911).

Cystischer Staar. (G.) Cystic cataract.

Cystitis. Inflammation of the bladder has only indirect relations to eye diseases, yet a purulent discharge, especially if it be due to gonorrhea or streptococci, may give rise to a metastatic panophthalmitis, or to similar processes in the ocular apparatus.

Cystitome. See **Cystotome.**

Cystitomy. See **Cystotomy.**

Cyst, Lenticular. CYST OF THE CRYSTALLINE LENS. If the lens capsule has been wounded, formed elements may enter the lens. Leucocytes, connective tissue, pigment, and cells of new growths have all been known to have penetrated the lens. Cysts of the lens capsule are extremely rare. Broxner (*Arch. of Ophth.*, March, 1908) observed a cyst of the lens capsule in an eye which had been operated upon for cataract twenty-six years before. The walls of the cyst were probably formed by the anterior and posterior layers of the capsule, which had been drawn apart by iritic adhesions. The fluid contents may have been derived from the aqueous humor.

Cyst, Meibomian. CHALAZION. HAILSTONE. TARSAL TUMOR. BLIND STYE. GRANULOMA GIGANTO-CELLULARE (DE VINCENTÜS). This subject has been fully discussed and illustrated, under the heading **Chalazion,** on page 1983, Vol. III, of this *Encyclopedia.*

Cystodycrasie. (F.) Dilatation of the lachrymal sac.

Cystodycrectasie. (F.) CYSTODYCRASIE. Dilatation of the lachrymal sac.

Cyst of the iris. Several varieties of cysts occur in this structure, and they have been classified in different ways, according to their particular pathological or clinical appearances. The following classification of Parsons seems to be the most satisfactory: (1) Implan-

tation cysts, including pearl cysts and atheromatous cysts, (2) Retention cysts, (3) Congenital cysts, (4) Cysts of the retinal epithelium, and (5) Parasitic cysts. To these must be added complex cysts, in the formation of which not only the iris but also the cornea and anterior chamber take part. These are usually either implantation cysts or cysts of inflammatory origin.

Implantation cysts of the iris may follow a cataract extraction, or any corneal wound which drags epithelium or hairs into the anterior chamber. Such cases have been recorded by Rockliffe, Stoeber, Collins, and others.

They present a mother-of-pearl appearance due to cholesterin crystals. They have been called pearl-cysts or cholesteatomata. They exhibit a lining of laminated epithelium and semi-solid contents, consisting of degenerated epithelial cells and globules. Epithelial cells or hair-bulbs transported to the anterior chamber find favorable soil for growth. They may remain quiet for a long time and then become active. When they grow the eye becomes painful, the tension rises, and a large part of the anterior chamber is filled by the cyst. Unless removed early, the growth may cause iritis, iridocyclitis, secondary glaucoma, or sympathetic ophthalmia.

Although epithelial cells, proliferating in the iris, usually result in cyst formation they seldom become malignant. Oatman (*Archives of Ophthalmology*, July, 1906) discusses the method of introduction of the epithelial cells into the iris tissue, which is of mesoblastic origin and devoid of epithelium. He disagrees with the implantation theory of Buhl and Rathmund, that, as a result of a perforating wound, a fragment of surface epithelium is carried into the eye and implanted in the iris and that these engrafted cells proliferate and form solid epithelial tumors or epithelial lined cysts and favors the extension theory of Stölting, that the epithelial cells are not detached from the surface and implanted in the iris, but that the surface epithelium, during the process of healing, spreads over and into the iris tissue exposed to the wound. Oatman states that if from any cause a corneal perforation remains open and no obstacle is presented to the progress of the ingrowing epithelium, the latter will not confine itself to the anterior division of the wound, but spreads beyond to contiguous parts. Such migration of cells may be followed by various unfortunate results; the interposition of epithelium between the wound surfaces may delay union or prevent cicatrization. In the latter case a corneal fistula will be established. The cells may extend to the iris or line the anterior chamber. Instead of spreading throughout the anterior chamber, the epithelium may be confined to spaces

created by inflammatory adhesions between the iris and cornea. Proliferating epithelium confined to iris tissue usually forms a cyst. This result is not wholly due to its confinement within a circumscribed space, as non-malignant, migrant epithelium appears to possess an inherent tendency toward cyst formation.

The author directs attention to this tendency of corneal epithelium to penetrate, as having a direct bearing on the treatment of corneal wounds and also to the importance of securing accurate coaptation of corneal flaps.

Schieck (*Zeit. f. Augenheilk.*, Vol. 29, p. 196, 1912) demonstrated a case of iris cyst in a 6-year-old boy who three years previously had been wounded with a hatpin. The cyst filled two-thirds of the anterior chamber, and was connected with a small subconjunctival cyst at the upper inner limbus. This was the site of the injury. The anterior wall of the cyst was grown fast to the posterior surface of the cornea. Von Hippel (*Klin. Monatsbl. f. Augenheilk.*, July, 1912, p. 104) showed a case of traumatic iris cyst which was remarkable for the presence, at the bottom of the cyst, of a hypopyon-like precipitate, the surface of which maintained a horizontal position when the head was inclined.

Retention cysts of the iris. Serous cysts occur in the iris, which are not lined by epithelium, and in which no history of injury can be obtained. Schmidt-Rimpler has suggested that some non-traumatic cysts may result from closure of the crypts normally present upon the surface of the iris, forming a retention, or perhaps more accurately, an exudation cyst. It has also been suggested that some of the congenital cases may be accounted for by fluid that has collected between Descemet's membrane and a pupillary membrane. Berry believes that the serous cyst is a kind of cystoid degeneration of the iris, leading to the formation of a diverticulum at the angle of the chamber.

Retention cysts are said to be always unilocular. They are often collapsed and folded when cut, so that appearances of multi-locular cysts are common in sections.

An unusual form of cystic growth was reported by Coats (*Royal London Ophth. Hosp. Reports,* March, 1907) which showed pathologically a development of the condition known as adenoma, or epithelial hyperplasia, of a ciliary process, while clinically it presented appearances which led to the diagnosis of sarcoma of the ciliary body and the eye was enucleated. In fact, however, no malignant disease was present, but the growth was a cyst within the stroma of the iris, at its extreme periphery. It arose undoubtedly in the epithelial lining

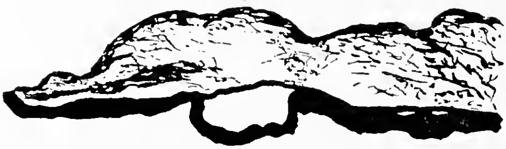
of the anterior part of the ciliary body, both layers having a share in its formation. If it be allowed that the cells from which the tumor originated are glandular, since they have a secretory function, the tumor in this case is not analogous to the true adenomata, but to retention cysts of a single glandular loculus with proliferation of the lining epithelium.

A retention cyst situated on the lower anterior margin of the iris, was reported by Pisani (*Trans. Ophth. Soc. of United King.*, Vol. 32, p. 56, 1912). The cyst had thin, translucent walls and clear contents. The anterior wall, which could be seen only with magnification and careful focusing, appeared to be in contact with the posterior surface of the cornea. The posterior wall could be seen through the anterior as a concave surface. The cyst in its growth appeared to have pushed the iris inwards, producing an iridodialysis. The cyst was transfixed with Ziegler's knife and the anterior wall divided; the cyst collapsed at once, and had not reformed when the patient was seen a month later.

Congenital cysts of the iris. A few cases of true dermoid cysts of the iris have been reported by Rosenzweig and Lagrange. They are practically identical microscopically with the pearl tumors or the implantation cysts, and it is doubtful in which category they should be included. Many of the retention cysts are congenital. A remarkable congenital cyst, lined by ciliated epithelium was reported by O. Becker and Krückow. The cyst lay in an anterior staphyloma. Congenital cysts occur in connection with colobomata of the iris, etc., and other malformations of the eye.

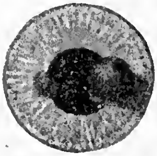
Cysts of the retinal epithelium of the iris. It has been pointed out by Treacher Collins that cysts may be formed by separation of the two layers of retinal pigmented epithelium at the back of the iris. (See figure.) Small cystic spaces of this nature are common in various pathological conditions. These cysts are due, according to Collins, to interference with the lymph-flow in the iris, which is aided, if not caused, by adhesion of the root of the iris to the back of the cornea, and further increased by fusion of the posterior wall with cyclitic deposits (partial or total posterior synechia). The accumulation of fluid is sometimes considerable, the anterior wall, with the main part of the atrophic iris, being bulged forwards. This is one cause of what may be regarded clinically as a partial bombé iris. In diabetes it is not unusual to find a condition of extreme edema of the pigment layer with the formation of numerous small cystic spaces. This same condition is occasionally seen in other degenerative conditions, but is markedly influenced by the presence of sugar in the aqueous.

Cyst of the pigment epithelium of the iris in a five-year-old girl was reported by Claud Worth (*Royal London Ophth. Hosp. Reports,* Jan., 1910), where the condition was first noticed in both eyes, when the child was one year old. The swellings varied much in size from time to time, and about nine months previously those in the left eye suddenly disappeared. The child had always been in good health, and the eyes had never appeared red nor inflamed. At the free edges of the pupil in the right eye are two cysts (see figure). They are faintly translucent to focal illumination. The pupil is quite free



Cyst of Retinal Pigment Epithelium. (Treacher Collins.)
Small cyst between the two layers of pigment epithelium; from an eye containing a melanotic sarcoma of the ciliary body. The iris was swollen and oedematous.

and mobile. There is no pigment in the lens capsule. In the left eye, on each side of the pupil, a little mass of pigment evidently marks the sites of similar cysts which have collapsed. Both fundi are normal. Neither eye shows any sign of past inflammation. This case is especially interesting because it shows no grounds for supposing that there had ever been any iritis.



Cyst of the Pigment Epithelium of the Iris. (Worth.)

Parasitic cysts of the iris. Cysticercus (q. v.) in the anterior chamber of the eye was first recorded by Schott and Soemmering, in 1829. A few other cases have since then been recorded, but they are extremely rare in this situation. The head of the scolex can sometimes be seen protruding in this situation. Its presence leads to severe plastic iritis. Filariæ have also been very rarely observed in the anterior chamber.

Complex cysts of the iris. These complex epithelial cysts involve not only the iris but also neighboring parts. Cystic spaces formed by shutting off portions of the anterior chamber, as the result of

inflammatory adhesions of the iris to the cornea, etc., are more common. Cases of this sort have been recorded by de Wecker, Knapp, Alt, and others.

At least three-fourths of the cases of cysts of the iris develop some months or years after a penetrating injury of the eyeball, as evidenced both by the history and by the discovery of a cicatrix, which generally lies at or about the sclero-corneal margin. They are usually single and limited to one eye. According to Brailey and Stephenson, they slowly increase in size, and become lobulated and flattened against the posterior surface of the cornea, which is rendered locally opaque. A few alternated iris fibres not infrequently cross the front of the cyst, the anterior wall of which is often thin enough to allow one to recognize its posterior, or uveal boundary. Grayish-brown particles of pigment flecking the wall of the tumor are sometimes observed. In the course of their further development, cysts give rise to distortion of the pupil, which becomes oval, kidney-shaped, irregularly triangular, or slit-like. The iris is occasionally retroverted. The lens may be displaced by the growing cyst, and may at a later stage become opaque. The diagnosis of cyst of the iris can be made by inspection, and the treatment is early and radical removal. Unless the removal is thorough the growth will recur.

Emil Juselius (abstract, *Oph. Review*, June, 1909; *Monatsbl. f. Augenheilk.*, Sept., 1908) after summarizing the theories which have been advanced by different authors to account for iris cysts of spontaneous, non-traumatic origin, gives the main facts of a case which had come under his own observation. The patient, a boy of six years, presented in the right eye a greyish tumor, translucent on focal illumination, lying upon the anterior surface of the temporal part of the iris. It was believed to be of spontaneous occurrence. The author excised the cyst along with the attached segment of iris, and cut it in serial sections perpendicular to the posterior surface of the iris.

Three structures were found: (1) The cyst, as clinically observed, developed in the anterior part of the iris stroma and lined with unpigmented stratified squamous epithelium. (2) Enclosed in the latter a small cyst formed of pigmented cells derived from, and attached by a hilum to, the pigmented epithelium on the posterior surface of the iris. (3) Rounded groups of cells lying between the pigment layer and the iris stroma, unpigmented and resembling the basal cells of the wall of the main cyst. The author refers the reader to a previous paper in which he traced the development of the musculature of the iris from the anterior layer of the posterior iris epithelium, and expresses the opinion that the cell groups found between the epi-

thelium and the stroma in the present case are derivatives of ectodermal cells which have failed to develop normally into the muscular tissue and which he believes may develop further into cysts of larger dimensions like the one which is the subject of his paper.

That the *diagnosis* of cyst of the iris sometimes presents some difficulties, is illustrated by the case reported by Emerson (*Arch. of Ophth.*, xl, p. 282, 1911). The patient was a man 52 years of age who had complained of no other symptoms except gradually failing vision. The tumor appeared to be almost entirely behind the iris and only the pigmented portion showed at the left side of the pupil under normal conditions. With the pupil dilated the tumor was seen to occupy about two-thirds of the entire circumference of iris, giving the pupil a decided U-shape, with the pigmented portion of the tumor showing. Vision was 20/50. There was slight cupping of the disc, and after the employment of euphthalmin there was increased tension. Transillumination showed no thickening of the iris or ciliary region. He was examined by a number of oculists some of whom believed it to be a sarcoma, others a cyst, and others were undecided.

Schoeler (*Klin. Monatsbl. f. Augenheilkunde*, May-June, 1911) relates the histories of two cases of *serous cysts of the iris* in which the disappearance of the cyst was brought about by the careful injection of a few drops of tincture of iodin into the cyst by means of a Pravaz syringe. Four years later no trace of the cyst could be seen.

Cyst of the lachrymal duct. It was once said by Camuset (*Revue Générale d. Opht.*, p. 556, 1883) that tumors originating in the lachrymal duct are full of clinical interest, because they are accompanied by an inflammatory appearance which often makes the diagnosis difficult. Of two described by Santos Fernandez (*Ophthalmology,* July, 1913) one was adherent to the wall of the upper left lachrymal duct of a man, and the other to the lower left lachrymal duct of a woman. In both of these instances water could be injected that penetrated to the throat and nasal fossa, without however going into the cyst. It was also possible to pass a silver thread through the duct, thus confirming its integrity, also made evident with Anel's syringe.

It was suspected, however, that the cyst had perforated the wall of the duct, through which perforation the cyst had become infected. On that supposition Fernandez dilated the lachrymal puncta. After the cyst had been emptied, its contents were washed out and proved to be pus, a small quantity of a yellowish liquid and a substance of hard appearance which was not examined but which was thought to be sebaceous and not calcareous.

The swelling of the cyst in the first case was the size of a large

pea and had lasted for forty years, but it disappeared immediately after the operation. The second case had had the cyst for a short time only, but was free from it as soon as the lachrymal puncta were dilated.

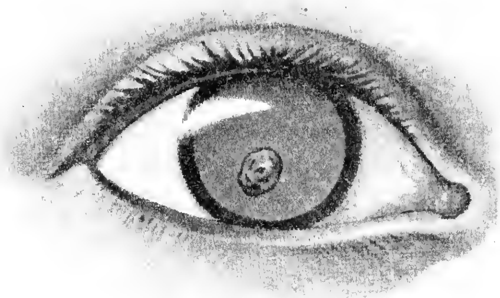
As can be seen, in these two cases there was not a primary affection of the ducts but a secondary one. The lachrymal duct, in spite its small size, is, as we know, the site of various affections that provoke the distension of its walls; for example, lithiasis lachrymalis, and streptothrix of the lachrymal duct; in the first instance the incision of the duct brings out small concretions of ammonium-magnesium phosphates. In the case of the leptothrix, there are curdled, oval masses of a yellowish color, formed by an interlacing of the mycelian filaments, surrounded by mucus.

Polypi and other neoplastic tumors of the lachrymal ducts have been described repeatedly but in all cases recorded to date the duct did not become affected until communication was established, infecting the contents of the cyst and causing suppuration. Mitvalsky described some years ago a case which, judging by the contents of the cyst, has some resemblance to these two cases.

Cyst of the vitreous. With the exception of the cysticercus (q. v.), and possibly one or two other forms of parasitic life, primary cyst of the vitreous is of extremely rare occurrence. Cysts of various forms and sizes are encountered occasionally in the vitreous body, but in most cases their origin may be traced to one of the solid structures of the eyeball, whence they have extended or proliferated into the vitreous.

An interesting demonstration of this unusual condition was reported by Tansley (*Ophth. Record*, Oct., 1899). After full dilatation of the pupil, the ophthalmoscope showed a floating body in the vitreous: spheroidal, of about the diameter of the optic disc, and at that time occupying about the centre of the vitreous chamber. (See illustration.) Its specific gravity was apparently but a trifle greater than that of the vitreous body, for when the eye was quiet it slowly settled toward the lowest portion of the cavity, and remained there in contact with the retina, but the slightest movement of the eyeball caused it to jump about with such rapidity that at first there appeared to be more than one. When the head was held forward it would approximate the anterior portion of the cavity, and when the head was thrown backward and held quiet it would settle toward the disc, so that apparently if there is such a condition as fluid vitreous, this vitreous was evidently in that condition. There were certainly no septa in the vitreous sufficiently strong to support this body. It had

no attachment with any other part of the eye, and would rotate in varying directions upon its centre, balloon-like, although it generally retained one erect position, seemingly because the dependent portion was a trifle the heavier. It was irregularly spherical with small indentations, somewhat resembling a potato, and this simile was made still more positive by there being spots and lines of pigment upon the capsule. It had a distinct capsule which could be made out clearly at the edges by reason of its different refraction, and this capsule was transparent excepting at its pigmented parts. The spots of pigment upon its posterior surface could be distinctly seen through the capsule and contents of the body, and recognized as being posterior to the anterior surface by their different motion or parallax. The spheroid was itself transparent or nearly so, and were it not for the delicate boundary line caused by the refraction of the capsule at the edges, and the spots and lines of pigment upon its surface, the body would be invisible. There was nothing white, opaque, or fibrous about the body. Repeated examinations of the patient showed no change in the appearance of the growth, and no tendency to inflammatory or glaucomatous symptoms. No suggestion was offered as to its origin, although the presence of pigment upon its capsule would indicate that at some time there had been inflammatory action.



Cyst of the Vitreous. (Tansley.)

A cyst of the vitreous was reported by Shine (*Arch. of Ophth.*, xlii, p. 398, 1913) which was considered as probably congenital. The

fundus of the right eye in a woman, 28 years of age, showed a peculiar cyst of the vitreous apparently about twice the size of the disc, which floated freely about on movements of the eyeball, but on cessation of movements always returned to the same point just behind the ciliary body below or slightly to the temporal side. The cyst was globular and of a steel-gray color and semi-transparent. It was composed of epithelial tissue, an outgrowth from the ciliary body, which became detached, although the fact that it always returned to the same position suggested a small invisible filament still attached to the ciliary body. The patient had never noticed any symptoms due to the presence of the cyst.

Cystoid bodies. Varicose nerve-fibres. These elements are generally found after injury of the retina, and especially in the nerve fibre layer. H. Müller regarded them as characteristic of albuminuric retinitis but, as shown by Roth and Baquis, they are present in other conditions. They are found within twenty-four hours after injury and are seen both in the centre and the periphery of the wound.

Parsons (*Brain*, Vol. 25, 1902) has observed that the cut ends of the nerve-fibres swell up on the central side, but this does not occur so much upon the peripheral side; hence the former are globular, the latter club-shaped. No regeneration of nerve-fibres was observed, although the club-shaped extremity of the part united to the cell of origin is indicative of continued, if lowered vitality.

Cystoid cicatrix. When the eyeball has been opened—as in the operations for iridectomy, cataract, etc.—and the newly-formed connective tissue filling the wound is not strong enough to stand the intraocular pressure, a cystoid cicatrix may be formed. In this case the cicatricial wall consists of epithelium, a thin layer of scar tissue, and the dark, pigment layer of the iris. Sometimes the scar tissue is so thin that the whole cicatrix appears quite black. When the iris fills only the posterior portion of the wound the anterior part may cicatrize as usual, i. e., most of the cells are directed vertically, and their union with the iris is looser than with the lamellæ of the cornea. Cystoid spaces may also be formed anterior to the iris. This portion of the subject is further discussed in Vol. III, page 2211, of this *Encyclopedia* under the captions, **Cicatrix, Bulging**; as well as **Cicatrix, Filtering.**

The *treatment* of these scars consists mainly in the application of the galvano-cautery and doing an iridectomy. When they are quite large, abscission may be combined with the use of the cautery. It is

always well to remember, however, that non-progressive and comparatively small bulging scars may well be left alone. All scar tissue tends in the course of time to contract and it is better not to take too many

Cystoid Cicatrix. (Parsons.)

chances with a condition that sometimes ends in further destruction of the eye as the result of operative interference.

Cystoid degeneration of the retina. Edema of the retina, as described by Iwanoff. Similar changes are found in the retina at all ages and at all portions of the retina. Cystoid spaces are found in both granular layers, are round or oval, and are surrounded by hypertrophied radial fibres. (Foster.)

Cystoide Vernarbung. (G.) Cystoid cicatrix.

Cystoid scars. See **Cystoid cicatrix.**

Cystoma. A neoplasm, especially an ovarian tumor, containing or made up of cysts.

Cystomyxoma. A neoplasm presenting the characters of both myxoma and cystoma.

Cystosarcoma phyllodes. (L.) Cystic adenosarcoma.

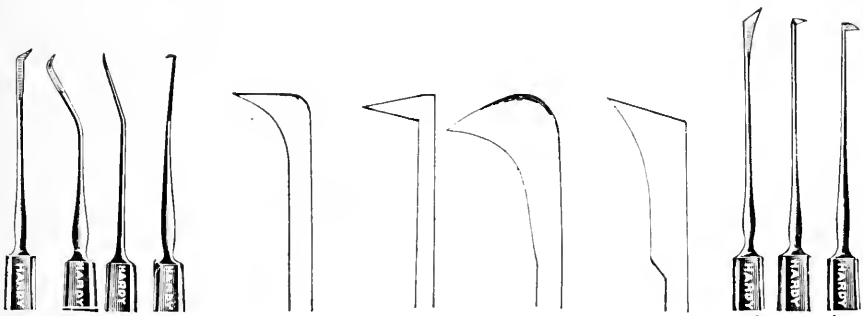
Cystotome. Cystitome. Capsulotome. An instrument invented by Lafaye for dividing the anterior capsule of the crystalline lens (generally) in the extraction of cataract. A common form includes a shank ending in a right-angled hook with a cutting edge. It is intro-

duced through the corneal incision and across and behind the pupil, when the capsule is more or less freely incised. The word is often written *cystitome.*

Webster Fox (*Presession Reprint, Sec. Oph., A. M. A.,* June, 1907) has described and depicted twenty different instruments of this class. See Vol. III, pages 1664 and 1665 of this *Encyclopedia.* Models by Knapp, Landolt, Beard, Hay, Wilder and other surgeons are there depicted.

While the von Graefe model has had many modifications it has not been much improved upon.

As Beard (*Ophthalmic Surgery,* pp. 66, 67) has properly said,



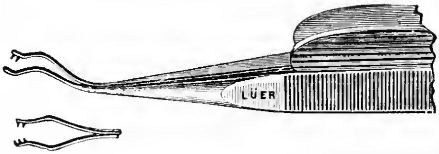
a b c d e e e e f g h

Cystotomes.

a, Neuter; b, Schweigger's; c, Graefe's (back view); d, Graefe's (side view); e, e, e, e, Various enlarged outline forms of cystotomes; f, Knapp's; g, Graefe's; h, Beard's.

"The instruments in the market are mostly modifications of von Graefe's. The outline of the blade is very suggestive of the side view of a goose's head. It will be observed that the back of the head of the goose is well rounded, and that the throat, from beak to neck, is a slight concavity. Now, what passes in this country as the Graefe cystotome is commonly an ugly, angular affair, being a mere spike, or peg. The back of the head is a right angle that catches in the incision and in the iris; and the throat is another angle in which rust and bacteria can accumulate. The idea seems to prevail that only a scratching point is required in a cystotome—that a cutting edge is a superfluity; and, doubtless, many a bungling capsulotomy is the result. A mere point does not cut, it simply tears. The point punctures the anterior capsule, and, unless there is an edge, and a sharp one at that, to make an incision, the alleged capsulotomy is nothing but an indiscriminate laceration. Knapp's cystotome is an

example of an incisive one, but it, too, is objectionable by reason of its angularity. Someone has given to the Graefe cystotome a small cutting extension backward which adds to its efficiency. The author has used for the past ten years a cystotome on the Graefe principle, only the head of the goose is larger, and the trenchant part is prolonged a little way into the neck. Continuing the simile, the tip of the beak is on a lower level than the top of the head. In other words, the back of the blade is a parabola. This disposition of the point makes it easier to introduce and to push beneath the iris than if it were on a level, as is the Graefe cystotome, or actually in advance of the rest of the blade, as in the Knapp instrument. From the back of the head to the tip of the beak is 2 mm. The centre of the crescent that constitutes the blade is 1 mm. wide, or even 1½ mm. The shank measures 22 to 25 mm. The objects in having it larger than the



The Double-curved Cystotome.

Graefe are to make of it a cutting instrument of greater significance, thereby enhancing the precision with which it can be guided and inspected, and, in a measure, to forestall the ravages of those who afterward put it in order."

Landolt's flexible cystotome is in the form of a small, sharp sickle-shaped knife.

G. Hays proposed a shape such as would be obtained by first lengthening to the extent of four lines the stem of the ordinary straight instrument, and then by bending the lengthened stem at right angles to itself, at a point four lines distant from its toothed extremity, this extremity being moved in a direction the opposite of that in which the tooth projects. (*Trans. Am. Oph. Soc.*, 1868, p. 62.)—(Wood's *System of Ophthalmic Operations,* Vol. 1, p. 475.)

In addition to the foregoing, a cutting cystotome is described by Cross (*Ophthalmoscope*, Vol. 11, p. 413, 1912). It consists of a narrow, double-edged, pointed knife, 5 mm. long, one edge of which cuts in its whole length and the other for 2 mm. at the point. The blade makes a slight angle with the shaft. Türk's cystotome (*Klin. Monatsbl. f. Augenheilk.*, June, 1913, p. 825) is built in general like the familiar Graefe instrument, but its blade consists of rather more than half a

circle, curved on the edge away from the shaft, and sharpened on three sides; really a very small scalpel, the depth of whose blade is almost equal to its length.

Attention may also be drawn to the two forms of cystotome here illustrated. Bettremieux's instrument is said to have some advantages over the average cystotome in that it is equipped with a loop and may be used for the purpose of that device.

Bettremieux's Cystotome.

Luer's double-curved cystotome conforms to the anterior surface of the lens and may be employed for rotation of the cataract as a preliminary to its extraction. See **Cataract, Senile.**

Cystotome caché. (F.) A cystotome with a concealed or guarded blade.

Cystotome emporte-pièce. (F.) A punch-like instrument devised by Rognetta for removing portions of the lenticular capsule in operations for cataract.

Cystotomia. (L.) Cystotomy.

Cystotomy. CAPSULOTOMY. CYSTITOMY. Opening the anterior (and occasionally the posterior) capsule of the crystalline lens in cataract and allied operations. This procedure, as well as the instruments used in its performance, is fully described and depicted in Vol. III, pages 1664 and 1683 of this *Encyclopedia.*

Cyst, Scleral. These are of rare occurrence, and their origin is in doubt, as few have been examined microscopically. Rogman and Hasner have recorded the presence of serous cysts in this region. Some authorities believe that these cysts are dilations of the canal of Schlemm; others hold that they are due to a congenital fistula from the anterior chamber into the sclerotic, which allows the aqueous to pass between the lamellæ of the sclera. Some authors attribute them to encysted choroidal exudates producing small staphylomata of the sclera. H. W. Woodruff (*Trans. Chicago Oph. Soc.*, May 15, 1911) has also fully described one of these rare growths.

Cysts, Conjunctival and subconjunctival. According to Parsons' classification, cysts of the conjunctiva may be divided into (1) Traumatic, (2) Retention, (3) Lymphatic, (4) Pseudo-cysts, (5) Parasitic, (6) Congenital. The term "serous cyst" is better avoided; it usually includes lymphathic and some retention cysts. When situated on the sclero-corneal margin they might be classed among the dermoids.

Traumatic cysts of the conjunctiva. These occasionally develop in the conjunctiva after injury, especially at the site of tenotomy wounds, or around foreign bodies. They are implantation cysts, due to the inclusion of epithelium, which subsequently grows, degenerates in the centre, and forms a cyst. Cirincione doubts the existence of traumatic cysts. In one case which he examined he found a cysticercus.

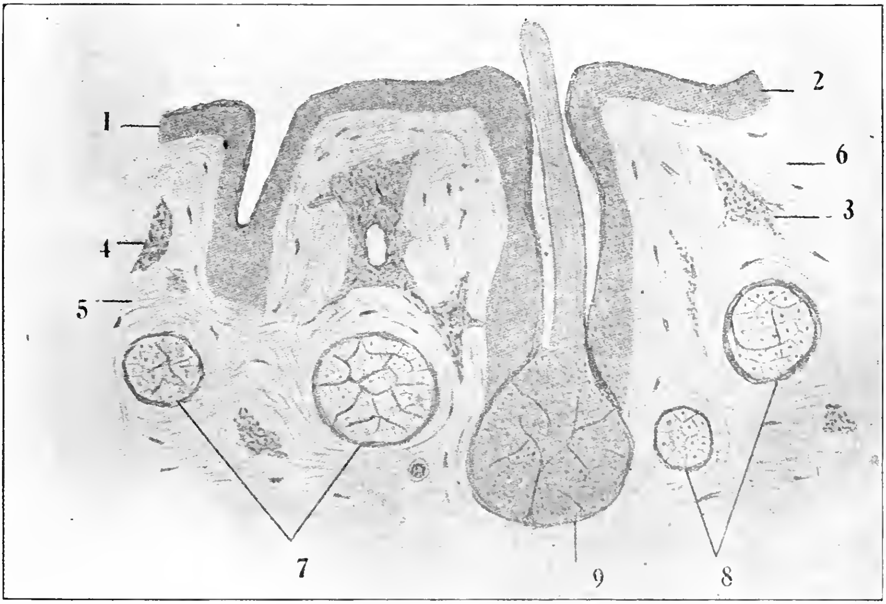
Retention cysts of the conjunctiva. These are usually small, developed in new-formed glands, the result of inflammatory processes, in the so-called Henle's glands, and rarely in Krause's glands. The retained fluids and débris alter chemically, and often form concretions. When found in Krause's glands, the cysts are generally small and lie in the upper or lower fornix; hence they cannot be due to Waldeyer's glands. The cysts are evidently formed in a tubular gland with many convolutions, so that they cannot be due to Henle's glands; moreover they lie deeper. The cysts of Krause's glands are relatively infrequent. The cysts which occur in old trachomatous granulations are really retention cysts in new-formed glands. Cirincione denies the new formation of true glandular depressions in the conjunctiva in inflammatory conditions. He found serous cysts of the bulbar conjunctiva much rarer than those of the fornix, if lymphatic cysts are eliminated. Superficial opaque cysts of the conjunctiva were also found by Cirincione in acute trachoma. They were small, ovoid, ash-gray, generally situated at the convex border of the tarsus. In chronic inflammatory conditions of the conjunctiva, false cysts may be formed by the pressing together of the folds and papillary outgrowths, so that secretion is retained in the depressions between them. It is probable that the cysts found in old trachomatous lids originate from such false cysts.

Lymphatic cysts of the conjunctiva are confined to the bulbar conjunctiva and cannot be pathologically differentiated from lymphangiectasis and lymphangioma. These cysts may be sessile or pedunculated, are yellowish and transparent, and are never very large. They are always multilocular.

Parasitic cysts of the conjunctiva. These are rare, and are due to varieties of cysticercus, C. cellulosæ (that of tænia solium) being commonest. Others are caused by filariæ. The hydatid cyst, due to tænia echinococcus, occurs in the orbit, and may appear as a subconjunctival cyst. Filaria loa occurs in residents in the West Coast of Africa, and not infrequently finds its way under the conjunctiva. An allied species, filaria inermis (Grassi), was found in a cyst by Cirincione.

Congenital cysts of the conjunctiva occur in some congenital tumors, especially naevi.

Echinococcus and serous cysts of the conjunctiva. The extirpation of these cysts should be carefully done, so as to remove the containing bag, if possible, unbroken. It was recommended by Herman Knapp to raise a small fold of conjunctiva with delicate forceps, snip it, and lay the tumor bare. The shelling out can be done with a scalpel or a delicate, slightly curved hand-chisel, the edges of which



Microscopic Section of a Conjunctival Dermoid Tumor. (Ball.) (Original drawing by Carl Fisch.)
1, 2, Epithelium of the conjunctiva; 3, 4, Round cell infiltration; 5, 6, Connective tissue; 7, 8, Sebaceous glands; 9, Hair follicle with sebaceous gland.

are rounded, and, like the adjacent portions of both sides, sharpened. The wound, which nearly always heals by first intention, may be stitched.

Dermoid cysts of the conjunctiva. Congenital in its origin, the dermoid tumor is generally a flat, solid mass of a reddish or whitish color. It is situated partly in the conjunctiva and partly in the cornea to which it is adherent. The surface is often dry and covered with downy hairs. Frequently other congenital anomalies are present, such as an eccentric pupil. Histologically it presents a connective tissue stroma covered with epidermis and containing hair-follicles,

sweat-glands, and sebaceous-glands. (See figure.) See, also, **Dermoids, Ocular.**

Epithelial-lined cysts of the conjunctiva, appearing after the expression operation for trachoma, due to exclusion of epithelial cells from communication with the surface, are described by Oatman (*Arch. of Ophthalmology,* May, 1907). He gives the clinical history and microscopic findings of such a cyst appearing on the lower conjunctival surface of the lower lid in a patient who had been previously operated on for trachoma. The author states that, in these cyst formations, the essential feature is "the segregation of some cells from the surface epithelium by inclusion in the substantia propria of the conjunctiva," and the ideal condition for giving rise to such cysts is the expression operation. He advises the breaking down of adhesions which follow trachoma expression.

A cyst of the corneo-scleral junction, of more than fourteen years duration, was reported by de Schweinitz and Crampton (*Ophth. Record,* xx, p. 42, 1911), in which it was impossible to ascertain whether or not it was congenital. History of injury was not elicited. The growth remained unchanged until about a year and a half before the patient came under observation, when it grew larger, and four months before its removal increased rather rapidly in size. It consisted of a small, sessile, cystic, irregularly pigmented growth, 4 by 7 mm. in size, protruding 2.5 mm. from the upper portion of the right eyeball, near the limbus, and slightly overhanging the cornea. Ophthalmoscopic examination was negative. After removal the growth was found to contain a bead of vitreous which protruded from a circular hole 4 mm. in diameter, looking exactly as if the sclera had been cleanly punched behind the limbus. Two years later there was no return and no discomfort. A microscopic examination of the excised tissues proved that it consisted practically of normal conjunctiva, with a small amount of uveal pigment, the conjunctiva having been a covering to the protruding bead of vitreous.

Auerbach (*Klin. Monatsbl. f. Augenheilk.,* June, 1909, p. 656; Dec., 1909, p. 779) reported a case of lymphatic cysts of both lower cul-de-sacs, in a man 59 years of age affected with trachoma. The cysts were lined with cylindrical cells similar to the endothelial lining of lymph vessels. The cells rested upon a basement membrane and in one place became continuous with the endothelium of a lymph vessel.

A case of subconjunctival cyst, occurring after removal of a corneal staphyloma is described by Bernard Samuels (*Arch. Ophth.,* Jan., 1913). Three years after the removal of the staphyloma, examination revealed a cyst of the orbit occupying an area larger than the nor-

mal eyeball. Operation showed the cyst to be filled with a clear fluid and enclosing within its walls the shrunken eyeball. The cyst was an implantation cyst and had spread posteriorly to the optic nerve, invading the entire space of Tenon.

Cysts, Corneal. When they occur in the cornea, cysts are usually of the implantation variety, and follow perforating injuries. One reported by Collins was situated partly in the cornea and partly in the sclera; it measured 9.5 by 5 millimetres and was lined with laminated epithelium. Generally corneal cysts are too small to be seen microscopically, and are found on microscopic examination of enucleated eyes. Schieck has observed the formation of four superficial corneal cysts in a case of blennorrhea with great chemosis. He believes that a superficial marginal keratitis was followed by the formation of pseudo-pterygia, beneath which the cysts developed.

Cyst spaces may also occur with uveal pigment in the walls. In these there has probably been prolapse of iris.

Small cysts in the epithelium (vesicular or bullous keratitis) are common. True lymphatic retention cysts are of great rarity. Czermak describes cystic spaces in corneal scars; in all the cases the iris was involved, a triangular space passing along the iris from the anterior chamber towards the cyst without directly communicating with it. Gruening reported an extraordinarily large cyst which developed between the layers of the cornea and sclerotic at the limbus, after an iridectomy. Tertsch described a cyst of the posterior part of the cornea in a buphthalmic eye, in which Descemet's membrane was separated from the corneal lamellæ, and formed a space which communicated with the anterior chamber.

Augstein (*Woch. f. Therap. u. Hyg. d. Auges.*, Vol. 16, p. 324, 1912) reports the case of a boy 8 weeks old, who presented a cyst 2 by 1.5 by 1.5 cm. in diameter; attached to the eyeball at the upper nasal quadrant of the cornea. On attempting to remove the cyst he found it contained vitreous, and communicated with the interior of the eyeball by an oval opening 6 or 7 mm. in diameter. The cyst was excised, the opening closed by deep stitches in the sclera and the conjunctiva drawn over it. Healing was undisturbed and three years later the eyeball was normal in size, the lids could be well opened, the cornea was clear, except the upper inner quadrant, and the anterior chamber and iris were normal.

Clausnizer (*Klin. Monatsbl. f. Augenheilkunde*, Vol. XLIX, October, 1911) reports the case of a corneal cyst developing in an eye three years after a severe lacerated wound of the cornea. The eye had made a prompt recovery after excising a piece of prolapsed iris, giving

nearly normal vision for one year. Attempted removal of the cyst, which almost filled the anterior chamber, resulted in iridocyclitis followed by enucleation. Microscopically, there were three distinct cysts located in the anterior section of the eyeball. They were closely united in places and were evidently implantation cysts due to the sinking in of the corneal epithelium which formed the covering of the cysts.

Tirumurti (*The Ophthalmoscope*, May, 1913) reports a case of corneal cyst in a girl aged ten years, who had sustained a finger-nail injury to the cornea of the left eye three months previous. Examination showed a phthisis bulbi, on the outer half of which was a cyst-like, vertically-oval tumor. Anteriorly the eye was staphylomatous. The tumor was not movable over the sclerotic, appeared translucent, the upper part bluish, owing to the bulbar conjunctiva covering it. It measured 19x6 mm., extending downward almost to the inferior fornix. The eyeball was enucleated. Pathologic examination showed the cornea converted into a multilocular cyst, the deeper cysts lined by several layers of endothelium resembling that of Descemet's membrane. Three small cysts and one large were present. No trace of lens was apparent and the retina was detached, separated from the choroid by a mass of colloidal exudate. The author was of the opinion that the injury to the cornea resulted in the escape of the aqueous humor, extrusion of the lens, and probably the escape of at least some of the vitreous humor. As a result of the sudden loss of support, the retina was detached all round and pressed the iris and the ciliary body forward "en masse." A portion of the endothelium of Descemet's membrane was evidently implanted between the corneal fibrous lamellæ through the rent in the posterior aspect of the cornea. This piece of implanted endothelium began to proliferate later, forming the main big cyst, which, as the result of great external resistance, sent prolongations between the interlamellar spaces behind to form smaller cysts, all of which communicate by narrow passages with each other.

Cysts, Dermoid, of the eyelid. Dermoid cysts are met with in connection with the eyebrows or the lids. They occur in the course of the fetal orbito-nasal fissure, and are most frequently situated at the outer angle of the brow. They lie beneath the orbicularis muscle and in contact with the pericranium of the frontal bone, which may be hollowed out under them. They are firm and rounded, smooth, and roll beneath the finger on the bone. They vary in size, but are not often much larger than a cherry. They are much more rarely met with at the inner angle of the orbit. In this location the growth may be connected by a pedicle with the dura mater, resembling a meningocele in that the brain pulsation is communicated to it.

The *treatment* of dermoids of the lids is, of course, excision. See **Dermoids.**

Cyst, Sebaceous, of the eyelid. MILIUM. The small, pearly-white tumor, frequently seen upon the eyelid, is supposed to be a retention cyst of the sebaceous gland. When multiple or occurring in patches, it may be mistaken for xanthelasma. The tumor contains epithelial cells from the prickle layer of the epidermis which has become snared off into the corium during embryonic life. Cholesterin and fatty granules are also usually present. While occasionally congenital it is usually not observed until after puberty. The lower lid is more often affected than the upper one.

Cysts of Moll's glands occur as small transparent cysts at the edge of the lid. They are retention cysts and therefore allied to sudamina or miliaria. The outer wall of the cysts consists of fibrous tissue in which a few fine blood-vessels and striped muscle-fibres are embedded; it is therefore in reality the stretched superficial layer of integument, the papillæ being flattened out and lost, while any hair-follicles present are atrophic and extended over the convexity of the cyst. The inner wall consists of epithelium lying on a layer of unstriped muscle-fibre, which shows, as pointed out by Sattler, that the cysts are derived from Moll's glands and not from ordinary sweat-glands, which do not possess this smooth musculature. In the multilocular cysts which are derived from the gland tubules, the epithelium consists of short cubical cells in a single layer. In the unilocular cysts, which are derived from the gland ducts, there is, according to Parsons, a double or treble layer of epithelium, consisting of flat cells with the long axes of the oval nuclei arranged horizontally, the cell walls being indistinguishable. Here the cells lie directly on the connective tissue, and there are no smooth muscle-fibres. The cysts contain a clear fluid, fairly rich in proteids. Under the microscope fine crystals are seen. Cholesterin crystals and calcium sulphate have been found; the latter is interesting, as sulphates occur normally in sweat.

Cysts of the ciliary body. These tumors were first described by Kuhnt in 1881, as a senile change. They are formed by separation of the non-pigmented from the pigmented layer of cells in the pars plana, near the ora serrata, and are therefore similar to those cysts of the iris which are caused by separation of the two layers of pigmented epithelium. Others are formed by separation of the pigment layer from the underlying ciliary body. The condition is caused by abnormalities in the transudation of lymph, and is always the result of degenerative or inflammatory conditions. Greeff recorded

the case of a very large cyst which resulted from atrophy of the ciliary body after irido-cyclitis following the extraction of a traumatic cataract. His explanation was that after the extraction a slow irido-cyclitis led to adhesion of some of the ciliary processes to each other and to the ciliary body. Closed spaces were thus formed into which more and more serous fluid was poured.

Cysts of the lachrymal gland. Dacryops. When it occurs in this region, the cyst is due to obstruction of one or more of the efferent ducts of the gland. Upon eversion of the upper lid the cyst may be brought into view. It was described by Soelberg Wells as a bluish-pink, semi-transparent, elastic, and somewhat fluctuating swelling, consisting perhaps of several nodulated segments of varying size. The swelling increases suddenly and markedly in size if the patient cries or the secretion of tears is stimulated by the application of some irritant to the conjunctiva. If the cyst be of considerable size it may be evident without eversion of the lid, and may also be detected by the touch. In some cases the occlusion of the efferent duct is incomplete, so that the cyst after becoming distended during the activity of the gland, presently returns to its previous smaller size through the slow oozing out of the tears. Cysts of the lachrymal gland are occasionally congenital. Owing to the delicate and ill-defined character of its walls, it is impossible to dissect out the cyst, and the treatment that has proved most successful, according to Theobald, consists in establishing an artificial opening between the cyst and the conjunctival sac. See, also, **Dacryops.**

Cysts of the orbit. Encephalocele. Cephalocele. This has been defined as a hernia of the brain, the sac of which is formed by the dura mater. The hernial ring on the intracranial side is, as a rule, formed by an opening in the suture between the ethmoid and frontal bones, at the expense of the horizontal plate of the ethmoid. On the orbital side the exit is found most frequently between the frontal bone, the nasal process of the superior maxillary, and the lachrymal bone, and the latter is sometimes entirely absent. The skin covering the tumor is, as a rule, normal, though sometimes firmly adherent to the sac. An encephalocele is always congenital, and is due to an arrest of development in the bony walls. It is often bilateral. There is no pulsation, though when accompanied by an angioma, which sometimes happens, pulsation may exist, complicating the diagnosis. The tumor generally grows rapidly in size, and most of the little patients die within a few weeks or months after birth.

Of the pure cysts which develop in the orbit, they may be classified according to their pathogenetic character into extravasation cysts, pig-

ment cysts, exudation cysts, retention cysts, and dermoid cysts. See, also, **Cephalocele.**

Extravasation cysts of the orbit. These include blood cysts, hematocele, and hematoma, which contain bloody contents. Most of the cysts of this variety were originally cases of dermoid cysts in which the bloody contents have been caused by some form of traumatism; only a few cases being on record which could be regarded as true blood cysts of the orbital tissues. The so-called pigment cysts, or melanotic cysts, may also be included in this category, as they are of doubtful origin, and are probably blood cysts which have undergone some pathological metamorphosis (Bull).

Exudation cysts of the orbit. A single variety of this form of cyst has been described as hygromatous degeneration of the orbital bursa. The tendon of the superior oblique muscle is surrounded in the trochlea by a bursa, and there are similar bursæ between the tendons of the levator palpebræ and superior rectus muscles. All serous cysts of the orbit are believed by Hyrtl, Demarquay, and others, to have their origin in these bursæ. The cysts contain a serous or synovia-like fluid (Bull).

Retention cysts of the orbit. Under this head de Wecker includes the atheromata, steatomata, and cholesteatomata, and asserts that they all originate in the skin follicle, because they are more or less closely connected with the eyelids. Hence he calls them "follicular cysts." Pathologists are generally agreed that all follicular cysts are varieties of true dermoid cysts.

Dermoid cysts of the orbit. These are to be regarded as fetal structures resulting from the invagination or involution of the external blastodermic membrane (Bull). They are not rare in the orbit. They form a group of cysts by themselves (teratoma). They are round and usually unilocular, though they may be multilocular. Their walls are quite thick, very vascular, and generally lined with epithelium. They probably arise in the anterior portion of the orbital cavity as they are usually situated outside of the limits of the funnel formed by the ocular muscles. They increase slowly in size and may reach an extraordinary development, but are of a benign character. They may be closely connected with the muscles, the eyeball, the sheath of the optic nerve, or the periosteum. Their contents may consist of epidermis, hairs, fluid fat and fat crystals, fluid, gelatinous, or solid constituents, and even skin and teeth, with occasionally chalky deposits.

A dermoid of exceptionally large size was reported by Moulton (*Ophth. Record*, March, 1898) in the orbit of a man thirty-two years

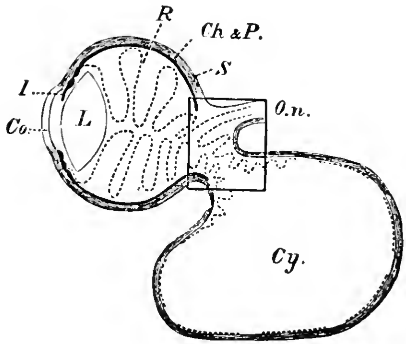
of age. The tumor had been present since the earliest recollection of the patient. It seemed to fill the entire orbit, protruding beyond the margins, extending downward on the cheek and crowding the eyeball almost out of the orbit under the outer end of the upper lid, where it lay concealed from view. It was covered by the stretched tissues of the lower lid and by the skin and fascia of the cheek. It was sensitive to pressure, and at times so painful as to require the administration of morphine. On lifting the upper lid, enough of the eye could be uncovered to show an intact cornea, a ball slightly movable in all directions, but turned decidedly upwards, and a mobile pupil. Vision was fingers at two feet. On removing the tumor, in attempting to dissect it from the bony floor, it was ruptured, and about three ounces of a gruel-like, inodorous substance composed of epithelial débris escaped. The sac extended fully to the apex of the orbit. The eyeball, now fully in view, was seen to be not more than one-half or two-thirds as large as a normal eye, and no attempt was made to preserve it in an orbit as much too large as it was too small. This enlargement of the cavity to nearly double the size of its fellow was evidently due to developmental changes and not to absorption, as the dilatation extended in all directions, involving the deeper portions as well as the rim, and there was no solution of continuity of the walls. See, also, **Dermoid cysts.**

Hematomatous cyst of the orbit. A subperiosteal blood-cyst, probably caused by an injury received in a duel, was reported by Denig (*Ophth. Record,* April, 1902). The tumor was situated behind and above the lachrymal gland and was connected with the orbital wall. This cyst was reached by means of the Kroenlein operation. It was pear-shaped and contained a brownish, bloody fluid. In the upper back portion of the orbit, near the apex, a hole about the size of a dime was seen in the bone, through which the dura was plainly visible, and there was distinct pulsation. Cases of spontaneous subperiosteal hemorrhages have been described by Holmes Spicer. They occur in infants suffering from malnutrition.

Congenital cysts of the orbit with microphthalmos. This is a peculiar congenital malformation, consisting of a large, transparent vesicle situated between the skin and the conjunctiva of the lower lid, which pushes the lid forward, and sometimes extends deeply into the orbit. It is always associated with microphthalmos or anophthalmos. Various views have been held in regard to the true nature of these cysts. Berlin believes that the cystoid structure has proceeded from those embryonic structures from which a normal eye is usually developed. This is probably the correct view. In the majority of the reported

cases the cyst was unilateral, though it has been found in both orbits (Bull).

In those cases associated with rudimentary eyes, the cystic swelling is usually situated in the lower part of the orbit or lower lid. It is often very thin-walled. The skin of the lower lid stretched over them presents sometimes a bluish hue. The cyst may be so large as to fill the orbit and to all appearances replace the eyeball; the small eyeball itself is usually situated far back in the orbit near the apex, and its presence or absence cannot be determined by clinical examination alone. It is this which has led to some of these cases being described under the head of anophthalmos. Dissection of these cysts



Diagramatic Representation of a Microphthalmic Eye, with a Cyst Attached. Co, cornea; L, lens; I, iris; R, retina much folded; Ch and P, choroid and pigment epithelium; S, sclerotic; On, optic nerve; Cy, cyst lined with atrophied retina. (Norris and Oliver.)

reveals that they are connected, usually by a thin neck, with the small, ill-developed eyeballs at their lower end and posterior parts, and that they are not separately formed cysts which have by their development checked the growth of the eye, as was supposed by some observers (Lang and Collins). The composition of the walls of these cysts seems to have two coats—an outer one of fibrous tissue continuous with the sclerotic, and an inner of more or less highly developed retina (see figure). The retina in the human fetal eye being normally in a folded condition, it seems likely that if there was some delay in the closure of the ocular cleft and in the development of the vitreous, the mere continued growth of the retina would tend to make it protrude through the cleft.

Bergmeister (Graefe's *Arch. f. Ophth.*, Vol. LXXXV, p. 1) has recently added a contribution to the theory of origin of these growths, from the study of two eyes, obtained from a 10-month-old child which

had died of gastro-enteritis. Both eyes were abnormally small and lay deep in the orbit. In the right eye the cornea and anterior chambér were normally developed. A persistent pupillary membrane showed signs of beginning resorption. There were small atypical colobomata of the choroid above the horizontal meridian, unconnected with the fetal cleft. There was also a typical coloboma of the choroid, a large mass of mesodermal tissue protruding into the vitreous cavity in the region corresponding to the fetal ocular cleft. To either side of this the inner layer of the retina (pars optica) was ectropic, its junction with the pigment epithelium occurring at some distance from the mass of mesodermal tissue. There were other developmental defects of the optic part of the retina, including a large tumor-like structure, smaller glious nodules lying free in the vitreous, and "rosettes." The optic disc was absent. The orbital cyst did not communicate with the vitreous cavity, but was continuous with the space between the pigment epithelium and the pars optica (primary optic vesicle). The inner lining of the larger of the two orbital cysts consisted of glial tissue, continuous on the one hand with the pigment epithelium, and on the other hand with the retinal folds. There was no central vessel in the orbital part of the hypoplastic optic nerve, which ran principally in the nasal wall of the cyst. The outer wall of the cyst had the anatomical structure of the dural and arachnoid sheaths.

The left and smaller eyeball showed lens anomalies; a persistent strand of mesoderm in the small posterior cavity of the bulb reaching to the posterior surface of the lens; scanty vitreous with persistent blood-vessels, and a rudimentary disc. The convolutions of the pars optica extended to an opening in the sclera and choroid, which topographically and anatomically corresponded to the optic canal. As in the first eye, this canal formed a communication with the orbital cyst, which was thus connected with the primary optic vesicle, and not with the vitreous cavity. The nerve stem on this side contained a central vessel. The structure of this cyst resembled that on the right side. There was a typical coloboma of the choroid, represented by mesodermal remains.

The novelty of the case consists in the fact that the neck of the cyst was identical with the optic canal, the larger orbital cyst on either side being really the cavity of the optic stalk, greatly expanded by fluid. The grounds upon which this conclusion is arrived at are: The identity of the external wall of the orbital cysts with the sheaths of the optic nerve; the presence of a hypoplastic optic nerve, which in the region of the cyst appeared as orbital section of the nerve; the

presence in the inner wall of the cyst of remains of the embryonic epithelium, and the communication between the pathological cavity of the fetal ocular stalk and the space between the pigment epithelium and the pars optica. (*Ophth. Literature* abstract, Sept., 1913.)

Echinococcus cysts of the orbit. These cysts are very rare but they have been found even within the lachrymal gland and in the frontal sinus. They have been known to extend from the orbit into the skull cavity, by gradual absorption of the orbital roof. An almost constant symptom is ciliary neuralgia. Any of the symptoms which accompany an increase of intra-orbital pressure may be produced by these cysts as they increase in size.

A case of hydatid cyst of the orbit was recorded by Reaney (*Indian Med. Gazette,* June, 1910) in an Indian musician. It was proved to be a hydatid by the discovering of a typical scolex. There had been pain in the eye for eight months, and proptosis one month. The lower lid was swollen and the vitreous cloudy. When the eye was enucleated the cyst, which was very thin walled, was found attached to the optic nerve.

Chronis (*Klin. Monatsbl. f. Augenh.,* May, 1909) records a case of hydatid cyst of the orbit in a Turkish woman 30 years of age. The tumor, which occupied the lower outer part of the orbit, had luxated the globe upwards and inwards and restricted its movements. Vision was reduced to seeing hand movements. The tumor was tapped and found to contain small scales of the tænia echinococcus. Later the cyst was excised. Microscopic examination showed numerous muscle fibres, probably from the inferior oblique. Hydatid cysts usually arise in the soft tissues of the orbit, but occasionally, as in this case, in the muscles.

Naso-orbital cyst. Heilbrun (Graefe's *Arch. f. Ophth.,* lxxix, p. 248, 1911) reports the removal, by means of the Krönlein operation, of a large retrobulbar cyst. The epithelium lining a portion of the cyst resembled that of the upper respiratory tract, and the cyst was therefore probably derived from congenitally detached nasal mucosa.

Pooley and Wilkinson (*Ophthal. Rev.,* v. 32, p. 202) record a case of temporary unilateral blindness due to pressure of the cystic distention of the corresponding maxillary sinus upon the optic nerve. The fundi were normal; the pupillary reflex on the affected side was lost. The field of the fellow eye was normal. The antrum was punctured through the inferior meatus and two drams of a straw-colored fluid drawn off. Later, by way of an incision through the canine fossa, a thin-walled pellucid cyst was found with some very small polypi.

Histologically the cyst was of the degenerative type formed within a mucous polyp.

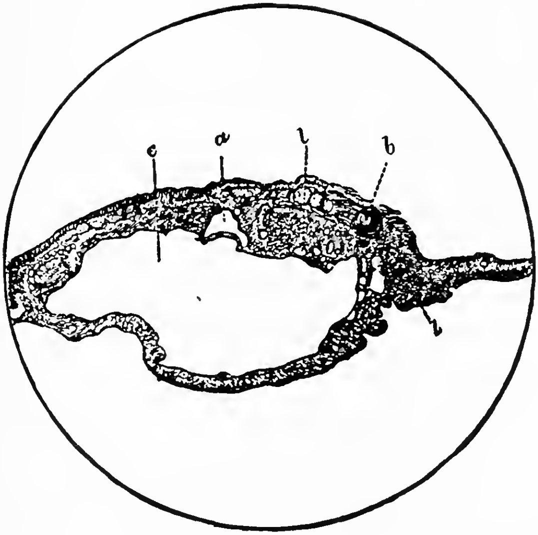
Removal of benign orbital cysts. Serous, atheromatous and dermoid cysts are sometimes met with in the anterior portion of the orbit. Their removal, according to the rules laid down by Herman Knapp, of laying them bare, stratum by stratum, with the knife, a curved hand-chisel, and scissors, sometimes using a grooved director, can in many cases be done without opening the bag; in others, for instance the thin-walled echinococcus cysts, it is easier and almost as sure to open the bag, liberate its contents, and inject a strong antiseptic solution, such as tincture of iodine, nitrate of silver, and the like. It should not be forgotten that these cysts are sometimes multiple. We should of course endeavor to remove them without sacrificing the eye, and without producing diplopia.

Cysts of the pars ciliaris retinæ. According to the testimony of Brailey (*Trans. Ophth. Soc. of the United Kingdom,* Vol. XXVII, 1907), these structures are frequently mistaken for sarcomata of the ciliary body. They are found in such a variety of conditions that he was only able to classify them according to their apparent mode of origin. Two changes, which play an important part in the origin of some varieties (limited to the cells of the unpigmented epithelium), are multiplication of the cells and vacuolation of the cell bodies. This proliferation is most frequently found in senile eyes, and is commonly associated with hypertrophy of the ciliary processes. The cells of the pigmented layer appear to play a more passive rôle, and even in cysts arising by simple detachment of the epithelium, it is the unpigmented layer alone which is affected, the adhesions between the pigmented epithelium and the underlying ciliary body being a peculiarly intimate one. The different modes of origin appear to be detachment of the non-pigmented epithelium, proliferation of the non-pigmented epithelium cells with the formation of a cavity arising either by simple separation of the cells, or by their vacuolation and destruction, and proliferation and union of the cells of adjacent processes, leading to a portion of the posterior chamber being shut off from the remainder.

The number of specimens examined was too small for him to come to any conclusion as to the relative frequency of these varieties. The content of the cysts was usually lost during the preparation of the specimen, but when present it consisted of a deep-staining, homogeneous, coagulable fluid.

Cysts, Retinal. Retinal cysts, which are rarely discovered before enucleation, are found in the detached retinæ of degenerated eyes,

and are due to circulatory disturbances. Liquid transuded from the retinal vessels form cysts, which may spread for some distance in the membrane. It is only when they are situated far forward and the lens remains clear, that they can be seen. They may be mistaken for tumors of the ciliary body, but the lowered tension and the history of the case will invalidate such a diagnosis.



Cyst of the Retina. (Treacher Collins.)
l, Dilated lymphatics; a, Space evidently formed by the coalescing of dilated lymphatics; c, Cyst; b, Blood vessels.

Derby (*Trans. Amer. Ophth. Soc.*, xii, 3, p. 827, 1911) reported a condition of probable cysts in the retinæ of both eyes of a patient. The possibility of a choroidal tumor lying behind the separated retina, could not, of course, be ruled out, but the separation was present in both eyes, and the localized protrusion in the right eye appeared to be in the separated retina itself, and could hardly be produced by a growth pressing forward from behind.

Multiple cysts of the retina. In an eye which had recently become blind, and in which for two months there had been some pain and congestion, Whitehead (*Trans. Ophth. Soc. of the United King.*, June, 1907) reported the presence of a number of translucent cysts in the retina, which was not detached. No definite structures were found, when examined microscopically. The walls of the cyst showed a very imperfect inner lining of flattened, endothelial cells, the outer

part having no definite limit. They were probably lymphatic cysts developed within the retina and separating its layers.

Cyst, Tarsal. CHALAZION. Retention cysts of the Meibomian glands. These cysts have been produced artificially by Deyl by obliteration of the ducts through cicatrization. This occurs frequently in the human subject in trachoma, which is a common cause of Meibomian cysts. See Vol. III, page 1983, of this *Encyclopedia*.

Cythion. (L.) A certain ash-colored collyrium mentioned by Celsus. See **Cythrion.**

Cythrion. CYTHION. Also called the tephrion. A common ash-colored collyrium for lippitudo in Greco-Roman times. It was composed of starch, tragacanth, acacia juice, gum, poppy tears, washed ceruss, washed litharge, and rainwater. For the exact proportions in which these ingredients were combined, see **Celsus.**—(T. H. S.)

Cytisin. BAPTITOXIN. SOPHORIN. ULEXIN. This agent is an alkaloid obtained from the seeds of the *Cytisus laburnum* and numerous other varieties of Papilionaceæ. It occurs in yellowish-white crystals, quite soluble in water. Both the alkaloid and its salts (hydrobromide, hydrochloride, nitrate) are violent poisons. It possesses a nervine action intermediate between curare and strychnia. It has been employed in migraine, asthma, etc.; and the dose, from $\frac{1}{20}$th to $\frac{1}{12}$th of a grain, is usually given hypodermically. Albutt found it principally a dilator of the pupil; he also adds that it blanches the optic papilla and contracts the retinal vessels. Phosphenes, and occasionally miosis have also been noticed. Aldridge (Nagel's *Jahresbericht*, 1872, p. 344) gives a short account of the poisoning of two children who had eaten portions of a laburnum; after which the pupils were noticed to be widely dilated and the fundal vessels considerably contracted.

Cytisus laburnum. See **Cytisin.**

Cytolysin. When antigens are injected into animals they produce antibodies in the serum and these are termed cytolysins.

Cytolysis. Cell-catabolism. Cell-destruction.

Cytometer. A device for measuring cells.

Cytotoxins. These are substances that have a specific destructive influence upon red corpuscles.

For example, upon the basis of his study of the biology of the lens by experiments in immunization, Salus (Graefe's *Arch. f. Ophth.*, Vol. 72, p. 514, 1909) criticizes Römer's theory of the origin of cataract through cytotoxins, and his suggested therapy by lens feeding. He finds that not only the therapy, but the suppositions upon which it is based, are not sufficiently well-founded. Bornstein (*Zeitschr. f. Augenheilk.*, Vol. 21, p. 483, 1909), experimenting with lens feeding

and inactive sera, from young and old persons free from cataract, and patients with rapidly developing subcapsular cataract, could detect no specific anti-bodies, and thus failed to confirm Römer's theory. From Römer's clinic Kuwabara reports experiments on the poisonous actions upon the lens of various acids and their salts of sodium and ammonium. The lenses were placed in test-tubes of isotonic solutions, containing the substances tested in strengths varying from 1 to 10,000 to 1 to 100. For control experiments the other lens was placed the same length of time, five or twenty hours, in the same isotonic solution, devoid of the substances to be tested. In every instance the control lenses remained unaltered. But the acids, both organic and inorganic, and their sodium and ammonium salts produced an injurious action upon the lenses exposed to them. Among the acids phosphoric showed the weakest action; while the sodium salts seemed indifferent, except by extracting water. (Review from the *Ophthalmic Year-Book*, 1910.)

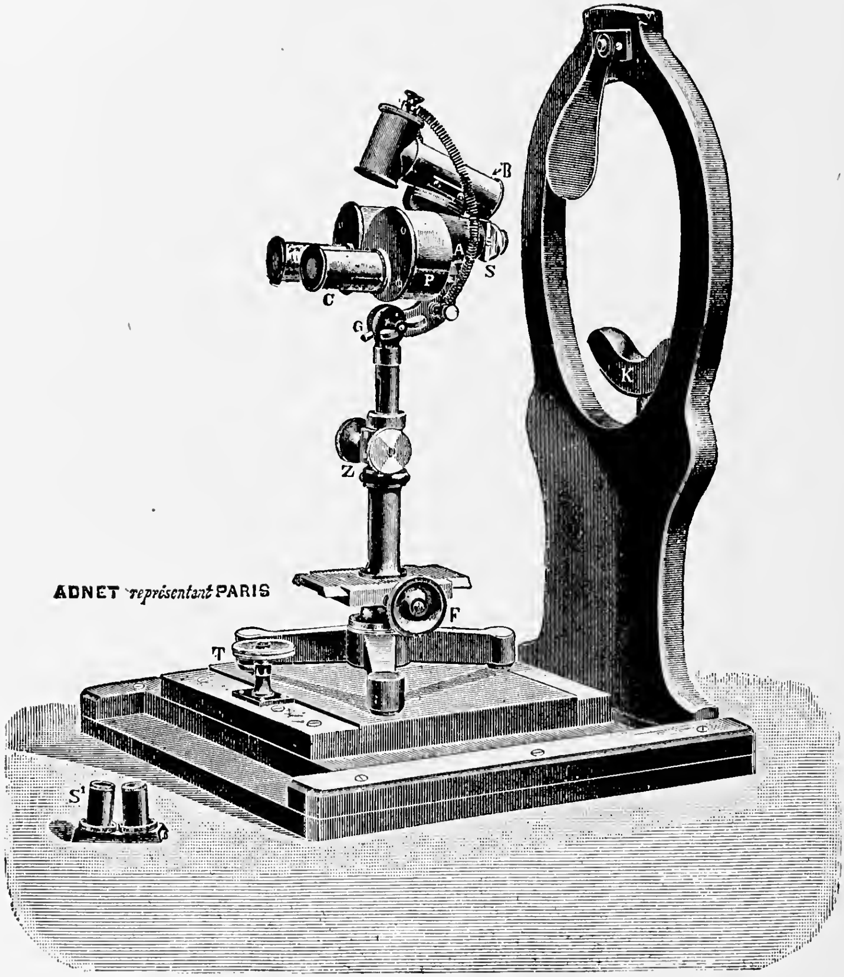
Czapski's corneal microscope. This is a binocular microscope (see the illustration) in which binocular vision is obtained by a combination of two microscopes. Each of these includes an objective (S), an ocular, (C), and a Porro prism (P). The prism allows the use of a short tube and gives a wide field.

Czermak, Experiment of. If we look towards an illuminated background, the sky for instance, through a pin-hole made in a dark screen, we see the opening under the form of a circle of diffusion. If we move a second screen, held nearer the eye, in front of the opening, it seems to move in a direction contrary to that in which it really does move. If, on the other hand, we move the second screen in front of the first, it seems to move in the direction of its real displacement.

Czermak's orthoscope. As is well known, the fundus is visible when the eye is immersed in water. Czermak (*Prager Vierteljahrsschr.*, Vol. 32) devised a box-like cup for this purpose, to which he gave the name of orthoscope. Two of its sides he made of metal, the other two of glass. In using this instrument he surrounded the eye to be examined with a thick layer of dough, filled the cup with water of 85° or 90° F., had the patient lean forward and close the eye; then the edges of the cup were pressed into the dough to prevent leakage. After this the eye was opened and a clear view of the fundus was obtained.

Czermak's osteoplastic resection. Czermak (*Deutsch. Med. Wochenschr.*, No. 39, 40, 1905; also *Die Augenärztliche Operationen*, 2nd Ed., Vol. I, p. 402) has considerably modified the original Krönlein pro-

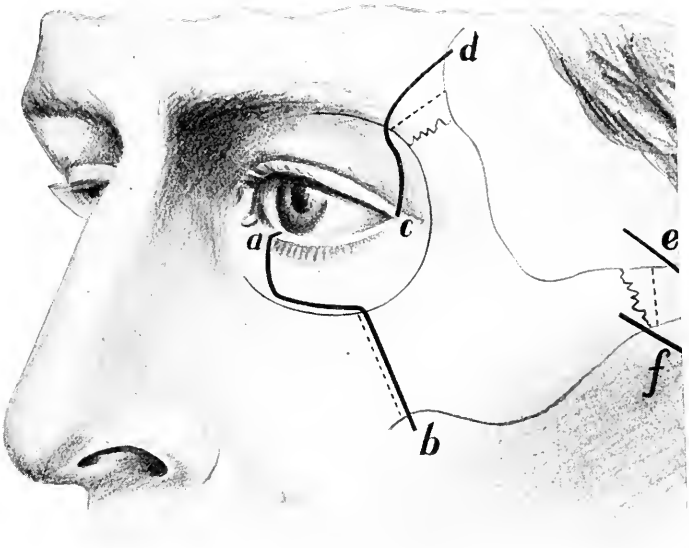
cedure so as to give more room for intraorbital operations. He would not discard the Krönlein procedure but reserves his own operation (1) for the removal of small tumors occupying the extreme apex of



Binocular Corneal Microscope of Czapski.

the orbital pyramid, (2) for tumors lying beneath the globe and reaching well forward and (3) for such growths as lie on the nasal side of the eyeball, in which case the eyeball would have to be drawn well outwards to permit of its removal from the front. His incisions compared with those of Krönlein may be traced in the figure.

It will thus be seen that in this operation the body of the malar bone, as well as the orbital process. is removed, i. e., most of the orbital floor. He uses for the purpose a small chain saw worked from behind forwards with a to-and-fro motion.



Czermak's Osteoplastic Resection of the External Orbital Wall.
a, b, c, d, e, f, The incisions through the soft parts. The dotted lines indicate the deviation of the bone sections from those of the usual Krönlein operation. (After Czermak.)

Czermak's phosphene is the appearance of a bright border around the visual field during a sudden relaxation of accommodation in the dark, said to be due to dragging on the retina about the ora serrata.

Czerny's osteoplastic frontal sinus operation. In 1895 Czerny advised that an incision be made along the upper border of the eyebrow from the nasal end of the center, then another smaller one through the nasal end of the first incision from the lower margin of the brow obliquely upward and inward. A curved incision of about two centimetres in height is now made through the periosteum, the basis of which is formed by the inner third of the upper margin of the orbit. Along this line the bone is opened with a chisel. The osteo-periosteal flap thus obtained, and forming the anterior wall of the frontal sinus, can be easily lifted and turned on its base, the periosteum and soft parts of it remaining intact. Through this window the frontal sinus

is now examined and scraped, and drainage into the nasal cavity by an elastic catheter is established. After this the flap is put back in its place and the skin-wound hermetically sutured.

Czoker's alum cochineal. This mixture is a solution for staining microscopic sections. Boil 7 grams of pulverized cochineal and 7 grams of alum in 700 c. c. of distilled water, until the quantity of fluid is reduced to 400 c. c.; cool, add a few drops of carbolic acid, and filter. After standing for a few days filter again, after which the fluid is ready for use.

D

D. In ophthalmology this letter is used as an abbreviation of *dexter* and *dioptry.* In Latin prescriptions it is also used for *detur,* let it be given.

Daae's color-table. See Vol. IV, page 2481, of this *Encyclopedia.*

Dacræmorrhysis. (L.) Dacremorrhysis. See **Dacryæmorrhysis.**

Dacriocistite. (It.) Dacyocystitis.

Dacry. (L.) See **Dacryon.**

Dacryadenalgia. (L.) Pain in the lachrymal gland.

Dacryadenitis. Preferably, *dacryoadenitis* (q. v.). Inflammation of the lachrymal gland.

Dacryadenoscirrhus. (L.) Indurated tumor (generally "hard" cancer) of the lachrymal gland.

Dacryæmorrhysis. (L.) Dacryemorrhysis. Originally, a flow of bloody tears; subsequently, hemorrhage from the lachrymal passages.

Dacryagogatresia. (L.) (Obs.) Occlusion of the lachrymal duct.

Dacryagogue. An agent that induces a flow of tears.

Dacryagogus. (L.) Tear-conducting; said of the lachrymal passages.

Dacryalloeosis. (L.) (Obs.) An abnormal state of the lachrymal secretion.

Dacrycystalgia. Dacryocystalgia. Pain in the lachrymal sac.

Dacryelcosis. (L.) (Obs.) Ulceration of the lachrymal apparatus.

Dacrygelosis. (L.), f. n. Alternating laughter and weeping, as in hysteria.

Dacryhæmorrhysis. (L.) Dacryæmorrhysis. Bleeding from the lachrymal apparatus.

Dacryhelcosis. (L.) (Obs.) Dacryelcosis, or ulceration of the lachrymal apparatus.

Dacryhemorrhysis. The weeping of bloody tears; a flow of blood from a lachrymal duct.

Dacryin. A peculiar substance contained in tears.

Dacryma. A tear; the lachrymal secretion.

Dacryoademitis. (L.) An older form of dacryadenitis.

Dacryoadenalgia. Dacryadenalgia. This is the name applied by A. Schmidt to neuralgia of the lachrymal gland. The condition is an extremely rare one, and it is a question whether the term should be

retained in ophthalmic literature. Possibly cases of supposed neuralgia of the gland are really due to lesions or functional disturbances located elsewhere.—(J. M. B.)

Dacryoadenitis. Inflammation of the lachrymal gland. This affection is extremely rare. It generally ends in resolution, although its termination may be *suppurative,* or *chronic* adenitis.

Acute dacryoadenitis begins with pain, redness, and swelling of the upper lid and conjunctiva, particularly of the outer extremity of the lid. In the beginning of the attack an enlargement of the gland can be readily felt. On elevating the lid, the lower part of the swollen gland becomes visible. The skin is movable over the mass, and, in pronounced cases, the eye is protruded and depressed. The upper lid droops. In the acute stage the gland is very sensitive, and eversion of the lid cannot be performed. Under these circumstances the eye may present a picture resembling that of purulent conjunctivitis or orbital cellulitis. When suppuration occurs, the pus may escape through the skin of the lid or through the conjunctiva. Probably the lower anterior part of the gland, the so-called palpebral part, is more often inflamed than the main portion.

Dacryoadenitis is more common in women and children than in men and adults. It sometimes occurs in epidemics in connection with mumps. Injuries, exposure to cold, and certain blood diseases—such as syphilis, gout, rheumatism, scrofula, and sepsis—and direct infection from the conjunctival cul-de-sac are causes. Metastatic dacryoadenitis occurring in patients with gonorrhea has been described by Terson, Panas, and Ferry.

Acute dacryoadenitis must be distinguished from orbital cellulitis. The differentiation can be made by the location of the point of greatest intensity of the inflammation. In some cases diagnosis may be impossible until after exploratory incision.

In the *treatment* of this form of dacryoadenitis, if seen in the earliest stage, the patient should be given a mild cathartic and any special medication which may be needed to combat any constitutional disease from which he may suffer. The application of iced compresses is valuable. If the case is seen later, hot packs are to be applied to the region over the inflamed gland. Pus may form in a few days, in which case an incision must be made. The inflammatory symptoms may subside, and the case then becomes chronic.

Acute dacryoadenitis affecting the palpebral portion of the gland is the subject of a paper by Beauvieux (*Arch. d'Opht.,* p. 772, 1909), who reports a series of six cases. The patients were all children ranging from 17 months to 13 years of age. Three recovered without

suppuration, and three developed abscess which opened spontaneously.

The subject of acute suppurative dacryoadenitis is also discussed by W. G. M. Byers (*Trans. Amer. Ophth. Soc.*, Vol. 13, p. 135, 1912).

Chronic dacryoadenitis is recognized by the history and by the presence of a swollen, lobulated, tender mass, situated at the outer and upper angle of the orbit. In a case of this character, seen by Snell, there was almost a complete absence of tears. Chronic inflammation of the gland may appear at any age. It is found in non-syphilitics as well as in syphilitics. Often its cause cannot be determined.

The *treatment* comprises the local use of iodin and mercurial ointments, and the internal administration of iodid of potassium and bichlorid of mercury. There is abundant evidence of the efficiency of these remedies in those who do not give a specific history, as well as in syphilitics. Where there is a history of rheumatism, the iodid or salicylate of sodium is of value. The use of a compress bandage is recommended by Galezowski.—(J. M. B.) See, also, **Lachrymal apparatus.**

Dacryoblennorrhœa. (L.) A mucous or mucopurulent discharge from the lachrymal passages.

Dacryocele. Dacryocystocele. A tumor or swelling of the lachrymal sac.

Dacryocyst. A name for the lachrymal sac.

Dacryocystalgia. (L.) Pain in the lachrymal sac.

Dacryocystatonia. (L.) A little-used term employed to indicate atony of the lachrymal sac.

Dacryocyste. Dacryocystitis. (L.) Inflammation of the lachrymal sac.

Dacryocystite blennorrhéique. (F.) Dacryocystoblennorrhea.

Dacryocystite des nouveau-nés. (F.) Dacryocystitis of the new-born.

Dacryocystitis. Dacryocystitis in general. Inflammation of the lachrymal sac, its walls or lining membranes. Although the various forms of this condition have a number of common signs and symptoms and though dacryocystitis is often discussed as if it were a pathologic entity, yet even a superficial consideration of the facts will at once demonstrate wide differences between the classes into which it is usually sub-divided. Under separate headings, therefore, will be briefly considered *acute, chronic, infantile, tubercular* and other forms of this disease of the lachrymal sac.

Some exceptional forms of dacryocystitis are mentioned in the *Ophthalmic Year Book* for 1912.

Lawrie (*Ophthalmoscope,* Vol. 9, p. 412, 1911) reports a case in a

child of seven, of a tense lachrymal sac from which a small amount of pus regurgitated through the canaliculi. The pus showed numbers of pneumococci. The glands behind the angle of the lower jaw were enlarged. Perfect recovery took place in ten days from purely expectant treatment.

In Morax's case of dacryocystitis (*Ophthalmoscope*, Vol. 9, p. 195, 1911), there was simultaneous formation of two subcutaneous nodules in the cheek, swelling of the preauricular and submaxillary glands, followed by almost painless prelachrymal abscess, cultures from the pus of which showed sporotrichum Beurmannii. The conjunctiva was normal.

From microscopic study of twelve dacryocystitic lachrymal sacs, Piccillo (*Ann. di Ott.*, Vol. 41, p. 3, 1911) is disposed to admit the existence of trachoma in the majority of cases of chronic dacryocystitis.

Mattice (*Klin. Monatsbl. f. Augenheilk.*, July, 1912, p. 27; *New York Med. Jour.*, Aug. 31, 1912, p. 457) found pneumococci in the conjunctiva in 43 per cent. of his extirpations of the lachrymal sac. Their virulence for white mice was slight. Pneumococci are not certainly evidenced by the appearance of the conjunctiva, whether pale or injected. Extirpation of the inflamed sac reduces the presence of pneumococci, the commonest cause of post-operative infection, about one-half. Their virulence is also diminished.

In Bane's case (*Colo. Ophth. Soc.*, Nov. 18, 1911; *Ophth. Rec.*, Vol. 21, p. 103, 1911) epiphora and mucopurulent secretion from the sac had existed for several years. Fluid would not pass into the nose though a No. 5 Bowman probe passed the usual length. But the probe could not be seen in the nose because of thickened tissue, exsection of which liberated the tip and permitted the ready passage of the fluid.

In the vast majority of cases inflammations of the sac and duct are due to the condition of the nasal chambers. The extension of catarrhal inflammation into the nasal duct causes swelling of the lining membrane, with a damming up of tears. Heat, moisture, and stagnation furnish favorable conditions for the multiplication of germs, with which the lachrymal secretion is always well supplied. Mucus and pus form within the sac and duct, and, although this pus does not cause severe inflammation when brought in contact with the conjunctiva, it does produce disastrous results in corneal wounds or in ulcers of the cornea. In a few cases periostitis with caries of the lachrymal bone, due to syphilis, produces a form of lachrymal stricture which is difficult to cure.

Struma, by acting on the nasal mucous membrane, must be regarded as an etiologic factor. A slight nasal catarrh may cause lachrymation, photophobia, and redness, in eyes which are otherwise normal, the excretory passages being permeable. In such cases spraying of the nose with a mild antiseptic and the instillation into the conjunctiva of a few drops of zinc-cocain solution (zinc sulphate, gr. ss; cocain, gr. j; water, ℥j) will be followed by relief. The next attack of rhinitis will reproduce the symptoms.

Certain cases of lachrymal obstruction are undoubtedly due to unskillful surgery. The habit, common among some practitioners, of slitting the canaliculus and passing probes upon every case showing epiphora, often results in the tearing of the membranous lining, the formation of cicatrices, and the production of infection. Such reckless treatment should be avoided. Occasionally a case of lachrymal obstruction is due to the lodgment of a piece of broken instrument, such as the point of a canaliculus knife, or the slipping of a style into the nasal duct.

As regards the nasal disease, a great variety is presented, embracing hypertrophic anl atrophic rhinitis, rhinoscleroma, the growth of polypi, nasal tuberculosis, malformation of the inferior turbinated body, the growth of exostoses, the presence of neoplasms in the antrum of the superior maxilla, etc.

That a veritable trachomatous inflammation of the tear-sac exists has been demonstrated by Vincentiis, Cirincione, Kalt, Kuhnt, and Raehlmann. Wernicke, who made sections of ten tear-sacs removed from trachomatous patients, found in them the same pathologic changes that exist in the conjunctiva in trachoma. This fact helps to explain the etiology of acute dacryocystitis. It is necessary to state, however, that the correctness of these observations has been disputed.

Lachrymal obstruction is common in the new-born. Stephenson found 1.75 per cent. among 1,538 out-patients of a children's hospital. In many of these the history showed the presence of a discharge, either from or shortly after birth. The eye is generally not red, the cornea is clear, and it is exceptional to find a swelling behind the tendo oculi. A plug of mucus or muco-pus is present at the inner canthus. Pressure on the inner palpebral ligament causes a discharge to appear. That the etiology of this disease in the new-born is different from that of the adult is shown by the rarity of the evidence of syphilis, of nasal catarrh, or of bone disease. The cause is to be sought in the embryologic history of the sac and duct, obstruction in the new-born being due to delayed absorption of the material which

exists during fetal life in the sac and duct, plus infection by bacteria. The bacteria found in the discharge from the sac and duct are numerous. They include pneumococcus, xerosis bacillus, staphylococcus pyogenes albus and aureus, bacillus coli communis, pneumo-bacillus, and bacillus fœtidus ozænæ.—(J. M. B.)

Of swellings that *simulate* dacryocystitis the most common is the so-called prelachrymal abscess—commonly due to injury of, or a syphilitic lesion at, the internal angle of the eye. This occurs as a swelling just above the internal palpebral ligament and slightly external to the lachrymal sac. When it opens, or is opened, pus flows from a collection that has no direct communication with the sac itself. Cysts and other small tumors in the same region may also simulate a dacryocystitis.

In a case reported by Henderson (*Ophth. Rev.*, Vol. 30, p. 352, 1911) the whole of the lachrymal fossa was occupied by a hard mass which was taken for the sac. At the operation it was found to be a dilated ethmoidal cell.

Luedde (*Am. Jour. Ophth.*, Vol. 29, p. 8, 1911) observed syphilitic disease about the inner canthus which was first diagnosed and treated as dacryocystitis; the irrigating fluid, however, passed freely into the nose, a point against inflammation in the tract. Recovery was rapid under large doses of potassium iodid, although the case became worse at first when small doses were employed.

The *pathology* of dacryocystitis has mostly to do with its bacteriology. Most of the earlier examinations of the discharges from the sac were found to contain chiefly staphylococci and streptococci; later pneumococci were often discovered in a virulent form. It is probable that the first investigators overlooked these or mistook them for streptococci. As Parsons (*Pathology of the Eye*, Vol. 2, p. 757) points out, streptococcus pyogenes is especially associated with phlegmonous dacryocystitis, and the pneumococcus with the simple type, though it is seldom found in pure culture. In a smaller number of cases Friedländer's pneumobacillus, or the so-called ozæna bacillus, is found. It was expected that this organism would be a common cause of hypopyon ulcer, but this expectation has not been realized. It has been found in patients suffering from ozæna, but even in these cases hypopyon ulcer is usually due to pneumococci. The organisms more rarely found in purulent dacryocystitis have been the bacterium coli, bacillus pyocyaneus, various unclassified bacilli, sarcinæ, actinomyces albus. Xerosis bacilli are common in non-purulent dacryocystitis (mucocele), and may be present as a pure culture. The mucous secretion is by no means harmless; Cuénod found pneumococci in

eight cases out of ten examined. In gangrenous "pericystitis" Veillon and Morax found the anaërobic bacillus funduliformis, another anaërobic bacillus, as well as streptococci. Cases of rhinoscleroma have been reported by Gallenga, but are very rare; so, too, is glanders.

It must be remembered also that dacryocystitis, not uncommon in the new-born, may be easily mistaken for ophthalmia neonatorum.

The *treatment* of dacryocystitis is a large subject which may be properly divided into conservative and radical. Among those advising the former is Goldseth (*Ophthalmology,* Vol. 7, p. 223, 1911) who divides dacryocystitis into catarrhal and suppurative forms, each having an acute and chronic stage. The catarrhal form in the acute stage is best combatted by treating the rhinitis usually present. Adrenalin chlorid 1 to 10,000, with washes of warm boric acid and warm compresses, is employed for the eye itself. As the disease becomes chronic, the sac may be irrigated with the boric-acid solution; and, as a last resort, probed. Suppuration, in the early stages, should be treated with cold compresses, to be replaced later by warm ones. The pus should be expressed from the sac, frequently if possible. If abscess forms, incision is to be made. Removal of the sac should be done as soon as the inflammatory signs have disappeared. The same procedure is applicable to the non-suppurative form which resists syringing and probing.

Kaiser (*Amer. Med.,* Oct., 1911, p. 548) recommends washing out the sac with hot salt solution after previous expression from below upward. He has seen severe argyrosis from injections of argyrol. He outlines the anatomy of the lachrymal passages, symptoms of disease, and more radical treatment. Shahan (*Am. Jour. Ophth.,* Vol. 29, p. 33, 1911) fuses tubular platinum or platinum iridium points of different sizes into the ordinary glass eye pipette for use in the lachrymal passages. Lundsgaard (*Klin. Monatsbl. f. Augenheilk.,* Vol. 2, p. 763, 1911) has devised two separate ends to be attached to an ordinary hypodermic syringe by means of a rubber tube for injecting the tear passages. They are both of platiniridium. The one is conical and of the size of a small conical probe for insertion into the canaliculus without previous dilatation. The other is cylindrical in form.

Von Knape (*Klin. Monatsbl. f. Augenheilk.,* Oct., 1911, p. 532) is an opponent of routine perfunctory probing and assumes that a swelling of the mucous membrane without visible secretion is more common than is usually supposed. Probing is injurious in such cases. He injects cocain adrenalin through the dilated punctum and then examines the passages with a Bowman's probe. If no stricture is found

further probing is to be avoided and the treatment should consist of injections of nitrate of silver, protargol, or zinc chlorid.

Dejounany (*Gazette des Hôpitaux*, 1911, Vol. LXXXIV, p. 1567) thinks that the various conditions following a stricture of the nasal duct are simply steps in the development of a dacryocystitis. He divides the lesions into two, for the sake of discussion: catarrhal dacryocystitis, and phlegmonous dacryocystitis. The treatment of the former consists in: (1) reestablishment of the lachrymal passages by dilatation of the canaliculi, their incision, probing, lavage of the sac, and its extirpation if necessary; and (2) treatment of the diseased mucosa, the conjunctiva, sac and nose. In the treatment of the phlegmonous variety, it is better to incise the sac without waiting for a fistula to form.

As a routine *treatment of dacryocystitis* Wessely (*Wien. Klin. Rundschau*, May 11, 1913) advises that a stylus be left in the lachrymal canal for 24 hours, and a few drops of tincture of iodin injected by means of a syringe with a platinum canula. The immediate effect of treatment is surprisingly good. In 24 out of 32 cases the discharge stopped after the first injection. In the worst cases only four injections were necessary. In order, however, to obtain a permanent good result it is essential that the nose be treated at the same time.

The Editor believes that unless adequate drainage into the nose can be obtained and maintained no permanent result is to be gained by using the lachrymal syringe in any form of dacryocystitis. Most cases are, of course, relieved but few are cured. Often they get apparently well in summer, to recur in winter, or the patient is made "comfortable" as long as the irrigation is continued with sufficient frequency. In the attempt to gain competent lachrymonasal drainage probing is of little value unless the patients can be taught to introduce their own probes. Failing effective drainage the infected sac should be obliterated or excised. See, also, **Lachrymal apparatus, Diseases of the**; **Dacryocystitis, Chronic**, and **Dacryocystorhinostomy.**

Dacryocystitis, Acute. It often happens that an acute attack of dacryocystitis develops from a chronic catarrh or distention of the lachrymal sac. In that case there is frequently rise of temperature, with a chill. The parts about the internal canthus, including the lids and nose, become red, edematous and tender to the touch. Frequently the discoloration and swelling simulates erysipelas, for which it may easily be mistaken. When the skin infection further advances a true phlegmonous cellulitis follows (*dacryocystitis phlegmonosa*), and pus forms in front of the sac. Here collections of pus develop and a true lachrymal abscess is likely to point below the tendo oculi.

Casali (*Ann. di Ottal.*, Nos. 1 and 2, 1909) finds that the pus of acute dacryocystitis almost uniformly contains streptococci, sometimes a mixture of other organisms; Friedlander's diplococcus and the bacterium coli are occasionally but rarely found. In the chronic form by far the most frequent organism is Fränkel's diplococcus; next in order of frequency come the staphylococcus, the streptococcus, the bacterium coli, and Friedlander's diplobacillus. Pfeiffer's bacillus may occasionally be present; other pathogenic micro-organisms are rare. Trousseau (*Ann. d'Oculist,* Vol. 141, p. 111, 1909) has observed three cases of intractable conjunctivitis following removal of the lachrymal gland. They resisted the usual treatment and seemed aggravated by antiseptics or irritants.

In a series of 26 cases of dacryocystitis examined bacteriologically Wakisaka (*Ophth. Zeit.*, June, 1909) found influenza bacilli in 19; alone in 4; pneumococci 16; alone 5; staphylococcus 1, and fusiform bacillus 1. Three cases of abscess of the tear sac showed streptococci in 2, and influenza bacillus in 1. Foster (*Manhattan Eye, Ear, Nose and Throat Hosp. Rep.*, Vol. 10, p. 65, 1909) has seen dacryocystitis caused by typhoid bacilli.

In the *treatment* of the acute cases one must remember that if the symptoms are at all well marked they are generally followed by the formation or rupture of an abscess externally. As Fuchs (*Text-Book*, p. 673) very properly says, "If we are dealing with an acute dacryocystitis in its very inception, we may try to prevent the development of an abscess. With this end in view, we sedulously express the fluid from the lachrymal sac, inject it with antiseptic solutions, and in the intervals apply a pressure bandage, which constringes it. If the inflammation has passed the initial stage, it is idle to endeavor to prevent the formation of an abscess; besides, the methods of syringing, expression, and compression, given above, could not be employed, on account of the swelling and painfulness of the parts. The only thing to do is to hasten the formation of the abscess, an object which is best attained by the use of moist and warm compresses. As soon as fluctutation makes itself apparent, we incise the anterior wall of the lachrymal sac, or that portion of the skin beneath which the presence of pus can be made out. A lachrymal fistula is thus artificially produced, through which the contents of the abscess and of the lachrymal sac itself are discharged externally. This is kept open by the introduction of a strip of iodoform gauze every day, until all inflammatory symptoms have disappeared and the secretion that exudes has lost its purulent character."

Verhoeff (*Jour. Amer. Med. Assocn.*, LX, p. 727, 1913) calls attention to a procedure in the treatment of acute dacryocystitis which, although first advocated by Agnew (*American Practitioner*, Jan., 1871) over forty years ago, has been generally overlooked or forgotten.

In the very early stages an attempt may be made to press out or wash out the contents of the sac through the canaliculi, but this is seldom successful. This failing, the sac should not be incised through the skin under any circumstances. Objections to the skin incision are that owing to its depth it gives imperfect drainage, that it requires to be "wicked" or frequently reopened, and that it insures a fistula which too often is almost impossible to heal and which interferes with extirpation of the sac later. The Bowman operation of slitting the canaliculus is less objectionable, but it also does not give good drainage, involves unnecessary mutilation, and is difficult to do under the inflammatory conditions prevailing. Superior to either of these procedures is the incision of Agnew. This is made through the conjunctiva between the caruncle and inner commissure of the eyelids. It involves cutting through the least possible depth of tissue, and not only gives adequate drainage but insures constant irrigation of the lachrymal sac by the tears.

The following quotation gives Agnew's views on the treatment of acute dacryocystitis and the description of his incision:

The common practice is to order leeches and hot poultices over the sac. This is a serious mistake. The first and imperative indication is to make an opening and let the contents out of the sac. * * * If the matter is already showing itself as a yellow or bloody mark beneath the cuticle, your course is simple; cut through the skin at the most depending part of the fluctuating tumor. * * * You have (otherwise) the choice of two other methods: either to slit up the lower canaliculus from punctum to sac and thus evacuate the matter; or, if that be prevented by excessive swelling, to make an incision behind the commissure of the eyelids between it and the caruncle, where you can reach the cavity of the sac with great ease, and do nothing to embarrass you in the after-treatment of the case. * * * You may then empty the sac without difficulty and avoid an external wound; nor does your procedure injure the canaliculi, or damage any appendage of the eye or interfere with after-treatment.

Agnew used a Beer's knife in making the incision.

Verhoeff uses an angular keratome, which is made to enter in front of the caruncle, then plunged through the sac to the bone, and the incision enlarged by cutting upwards and outwards. The lachrymal duct is immediately probed through the incision, using in adults

first a No. 12 Theobald probe, then always a No. 14, and finally, if possible, a No. 16. The large probe is left in until the patient begins to regain consciousness, in order to prevent bleeding from the duct.

For the after-treatment he directs the patient to press on the sac from time to time and keep the conjunctival sac free from pus with a lotion of boric acid.

On alternate days following the operation the duct is probed through the incision, a probe one or two sizes smaller than the largest probe used at the operation being introduced. The probing is done under cocain anesthesia and is almost painless, owing to the ease with which the probe is passed. The probe is allowed to remain only momentarily. Without probing the incision quickly closes. The result of this treatment is always most gratifying. Improvement begins at once, and in most cases within a week, to all external appearances, the condition is practically normal.

Dacryocystitis blennorrhoica. (L.) Suppurative inflammation of the lachrymal sac. See **Dacryocystitis, Purulent.**

Dacryocystitis, Catarrhal. DACRYOCYSTOBLENNORRHEA. MUCOCELE. This condition is generally due to an incomplete stenosis of the lachrymal passages or is an acute attack which has not resulted in a suppurative infection. Its usual symptoms are epiphora with a mucoid discharge from and dilation of the sac, and a catarrhal conjunctivitis with the symptoms proper to that condition.

The cause of the original disease, often lues, should be sought for and cured. The use of adrenalin sprays to the nose is usually of benefit as it reduces the swelling of the nasal mucous membrane, and this *treatment* should be employed in connection with applications to the duct itself. The syringing of the canaliculus and duct, first with adrenalin and cocaine or with a 10 per cent. codrenin (q. v.) mixture may be followed by the use of astringents introduced with the lachrymal syringe. Some of the best of these are 20 per cent. of glycerite of tannin in water, 1 per cent. nitrate of silver, 1/3000 calcic, zinc or potassic permanganate (q. v.) creolin 4 per cent., toluidin blue 1 per cent. or zinc chloride ½ of one per cent.

Thomalla advises the following mixture under the name rhinalgin, to be made up as a suppository and placed in each nostril twice daily when there are any nasal complications: Alumnol., 0.01 (gr. 1/6); Ol. valerian; Menthol, āā 0.06 (gr. 3/8); Ol. theobromæ, 1.00 (gr. xv).

When fluids can be injected into the nose a good antiseptic and astringent lavage can be had from: Aluminii acetatis, 3.00 (gr. xlv); Aquæ dest., 100.00 (fl. ℥iijss).

J. A. Andrews injects into the nasal duct dilute tincture of iodine combined with glycerine and sodium bicarbonate, the strength of the iodine solution varying according to the nature of the case.

Dacryocystitis, Chronic. The origin, course, pathology and the general treatment of chronic dacryocystitis have been considered under **Dacryocystitis,** yet there may be placed under this heading a few additional remarks on the essentially chronic forms of the disease. The *Ophthalmic Year-Book* (1913) mentions the case of Snell (*Ophthalmology,* Vol. 10, p. 22, 1912), a man aged 65, who had had chronic inflammation of the tear-sac for some years. On pressing the eyeball in and backward a large quantity of muco-pus was discharged through a fistula which had opened over the lower end of the sac. The fistula was enlarged, and by means of a probe it was demonstrated that there was an opening backwards between the sac and the orbital cavity through the lachrymal septum. There was no limitation of motion, and vision was normal. Six weeks later optic neuritis set in and the patient consented to extirpation of the sac. The operation revealed a window 10 to 15 mm. in diameter in the outer wall of the sac, opening into the orbital fat. As the discharge from the fistula did not decrease, a secondary operation was done and a small pocket lined with mucous membrane was removed from under the tendo oculi. Healing was prompt. Vision after four days was 20/100.

F. P. Calhoun (*Charlotte Med. Jour.*, April, 1913) does not follow conservative treatment except in a few selected cases, but from the very beginning extirpates the sac. The indications for removal, as he sees them, are as follows: "1, the unwillingness or the inability on the part of the patient to submit to a long course of the probe treatment, a timidity on the part of the patient that would likely render the probe treatment unsuccessful; 2, evidence of history of previous attacks of phlegmonous, or acute, dacryocystitis; 3, presence of any indication for an operation on the globe, and especially a cataract extraction; 4, an ulcer of the cornea caused from dacryocystitis which resists all forms of treatment; 5, finally, if after a considerable length of time these cases discontinue the probe treatment and a failure results, the sac should be removed." He usually prefers extirpation under a local anesthetic and he believes that in a series of cases 90 per cent. is a conservative estimate of those in which a complete cure has resulted.

Priestley Smith (*Ophth. Review,* Vol. 30, p. 257, 1911) highly recommends permanent styles made of well annealed silver wire in the treatment of mucocele and chronic dacryocystitis. He has entirely

discarded periodic probing and rarely employs destruction of the tear passage. The same method was practised, and was advocated by Chas. Hermon Thomas, of Philadelphia, twenty years ago, in a paper read before the Ophthalmic Section of the American Medical Association. His styles were made of lead and he incised strictures in the duct with a special stricturotome.

By means of special instruments Ostwalt (*Ann. d'Ocul.*, Vol. 146, p. 376, 1911) places a permanent drain of strands of thread in the lachrymal canal, the upper end of which is stuck to the forehead, the lower left free in the nose, or in the case of children, the lower end may be brought out over the alæ of the nose and tied to the upper extremity. The threads can be readily cleansed by withdrawal of the same by traction upon the lower extremity. He reports a number of good results from the method.

Fergus (*Ophth. Review*, Vol. 30, p. 231, 1911) thinks that excision of the sac is the most efficient treatment of chronic lachrymal suppurative disease. Irrigation and moderate-sized probes such as do not require slitting of the canaliculus he admits to be justifiable but require a very long period. He strongly objects to the use of the canaliculus knife and to styles. The essence of the disease in his opinion is a septic mucous membrane and not a stricture.

G. F. Libby (*Annals of Ophthalm.*, Jan., 1913) has also reported the case of a man who for twenty years had been regularly squeezing out the pus which collected in a diseased lachrymal sac. The condition had been treated by simple washing of the sac and subsequent filling with 25 per cent. argyrol solution, and at the time of reporting, the discharge had entirely ceased. The punctum had been gradually dilated with a Ferguson dilator, without slitting the canaliculus. The argyrol solution now passed through into the nose. The argyrol was not used until twenty-four hours after the punctum was dilated, because of the possible risk of staining the deep tissues.

Destruction of the infected, infiltrated and distended sac so common in the chronic forms of dacryocystitis, is brought about by the *application of trichloracetic acid*, as an alternative or substitute for exsection, highly recommended by Harold Gifford. He directs that it be done under local anesthesia, as follows: Infiltrate the tissues well down to the sac with one or two per cent. cocaine, combined with a little adrenalin.

Incise the sac three-sixteenths to one-quarter of an inch inward from the caruncle, making a vertical cut one-quarter of an inch long, including the greater part of the palpebral ligament. Be careful not to squeeze the sac out before the incision, since a distended sac is

naturally much easier to locate. When once in the sac it is well to introduce a groved probe and extend the incision with the angled knife to the full quarter of an inch, or thereabouts.

Then pack the sac with a piece of iodoform gauze dipped in zinc ointment. This should be a narrow strip doubled so that the part that goes into the sac has no loose fibres.

At this point the methods diverge, according to the urgency of the case.

If it is important to complete the operation as quickly as possible, wait until the bleeding is stopped. Prepare half a dozen small applicator swabs, with cotton on both ends, to dry out the sac. Have one applicator, preferably a slender one of metal, with cotton wrapped firmly on the end so as to make a ball about an eighth of an inch in diameter. Apply zinc ointment over the skin surrounding the external incision and for a short way into it.

Separate the lips of the wound well down toward the internal incision with any pair of slender forceps. Put two or three drops of liquefied trichloracetic acid into the cavity, then scrub the interior of the latter thoroughly with the ball swab referred to, being extra careful to reach the cupola and the cellar—in fact every part of the interior of the sac. Dry out the cavity again, dip the ball swab in trichloracetic acid once more and give an extra rubbing for good measure. There is not the slightest danger that I have ever seen of overdoing this cauterization. A bulb-pointed lachrymal probe does very well to rub in the trichloracetic acid, though I generally use the ball swab referred to.

Once in a while the canaliculi need some separate cauterization—generally not.

Dry out again, syringe out with any cleansing solution, fill the cavity lightly with aristol powder, put zinc ointment on the skin surrounding the incision and apply any light, moist or vaseline bandage. The latter may be left off after a day or two, and nothing further will be required except to keep the skin around the cut soft with a little zinc ointment or vaseline until the healing is complete. It saves time if instead of finishing it all on the first day the cauterization is left until the second day, when the opening into the cavity is more patent and the cauterization more easily carried out.

Kuhnt's dissertation on the treatment of chronic diseases of the lachrymal duct suggests that we fail in the treatment of these ailments because we consider them as primary diseases. Examination of sixty-three cases of dacryocystitis showed lesions in the ethmoid cells, in the antrum of Highmore, and other endonasal changes. Only three

per cent. had no nasal defect. The author describes the various extra- and endonasal operations, and comes to the conclusion that extirpation of the sac is indicated in tuberculous or lupous dacryocystitis; or one complicated with ozena; cases with manifest polypoid changes of the mucosa; atrophy of the sac, as in trachoma, and all cases where disease of adjacent bones is apparent or where an intraocular operation is imminent.

Dacryocystitis, Congenital. See **Dacryocystitis, Infantile.**

Dacryocystitis, Infantile. DACRYOCYSTITIS OF THE NEW-BORN. CONGENITAL DACRYOCYSTITIS. Lachrymal obstruction in the new-born is not as uncommon as it was at one time supposed. Moreover the prognosis is more favorable than similar conditions in the adult. As Jackson, Donald Gunn and others have pointed out the obstruction is rather one of lack of development than of infection, swelling or stricture of the canal ducts.

The treatment should at first be non-surgical and consists in keeping the parts clean, by the use of simple washes like the following: Sodii. borat., gr. xxx; Sol. adrenalin. chlor. (1:1000), fl. ʒii; Aquæ dest., fl. ℥ii.

After cleansing the sac about six times in the 24 hours a few drops of this mixture should be instilled in the eye, to be followed by pressure over the lachrymal sac. Later on, under cocaine or a general anesthetic, an attempt should be made to syringe the duct into the nose, first by solution of adrenalin chloride 1 to 2000 and subsequently with a 0.20 per cent. of zinc chloride. Any nasal disorders should be at the same time carefully treated. If this plan be carried out operative measures may, in the majority of cases, be avoided and a cure brought about in a few weeks or months.

In the lachrymal stricture of the new-born J. M. Crawford makes use of pressure applied over the sac and repeats this several times a day as an adjunct to other remedies.

Fage (*Archiv. d'Ophtalm.*, 1911, Vol. XXXI, p. 650) thinks the cause of this condition is arrest of development, or occlusion of the inferior meatus of the nose or the nasal canal. Though the obstruction may originally be of an inflammatory nature, it is probably never due to blennorrhea neonatorum. Three to four weeks after birth a tumor is noticed in the internal angle of the eye, and this may be accompanied by pain and redness. An incision yields mucus or muco-pus. It may disappear spontaneously. Treatment consists in expression, probing and incision if necessary.

Fage (*Ann. of Ophth.*, Vol. 21, p. 166, 1911) has also stated that the infection may originate in the conjunctiva, but it frequently starts

in the nasal chambers. He observed an instance in which the disease developed as a complication of inflammation of the ethmoidal sinus, and was cured by incision and drainage. Axenfeld observes that the ethmoidal sinus is undeveloped in the new-born. The appearances may be various; besides the milder forms which may be mistaken for simple conjunctivitis, cases of medium severity are also met with. In both cure, spontaneous or following simple injection and probing, may take place. Severe cases of long continuance where infection is the principal factor also occur. This may lead to abscess or fistula. Certain anomalies such as congenital fistula from loosening of the crista lachrymalis, and syphilitic and tubercular periostitis and finally traumatic deformations (*e. g.* the forceps) are to be mentioned.

Cassimatis (*Clin. Ophtal.*, Vol. 17, p. 417, 1911) reports a case of double purulent congenital dacryocystitis. Probing showed extraordinary width of the lachrymo-nasal canal; but led to no improvement. A single injection of physiological serum effected a perfect cure on one side; and two injections brought about a similar result on the other. The results are explicable on the assumption that the injection freed the various openings, especially the one in the inferior meatus.

Dacryocystitis, Metastatic. The occurrence of a lachrymal sac infection brought from distant depots is quite rare. It may, however, occur in tuberculosis, lues and gonorrhea. Its *treatment* is that of the primary lesion together with the conduct of dacryocystitis in general.

Dacryocystitis phlegmonosa. (L.) PHLEGMONOUS INFLAMMATION OF THE LACHRYMAL SAC. This inflammation of the cellular tissue about the tear sac is characterized by infiltration of the skin and subcutaneous tissue with serum and lymphoid cells. There is a very hard, brawny, infiltration of the parts with prominent swelling of the region of the sac. This condition spreads to all the neighboring tissues. No pus can be pressed out from the puncta; there are great pain and local heat of skin, and often a rise in the general temperature. The lids are often entirely closed, and the skin is purple and glazed.

It almost invariably happens that pus burrows in front of the sac, the abscess finally bursts, and a fistula forms, the mouth of which, surrounded by exuberant granulations, forms below the tendo oculi.

The *treatment* is that of acute dacryocystitis with lachrymal abscess and fistula.

Dacryocystitis, Suppurative. DACRYOCYSTITIS PURULENTA. DACRYOCYSTITIS BLENNORRHOICA. Acute attacks of inflammation of the sac and its lining, especially from repeated attacks of catarrhal inflammation, often end in the sac becoming filled with pus. Of course the primary source of most of these cases is a stricture of the nasolachrymal duct, and the final outcome of such a case will largely depend upon whether the obstruction is removed or the sac excised before further damage is done to the lachrymal apparatus. In other words, the *treatment* of such a case resolves itself into the treatment of dacryocystitis in general (q. v.).

Dacryocystitis, Tubercular. This form of the disease is rare; it may be either primary or secondary. Among others Lundsgaard (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1909, p. 131) observed tuberculosis of the skin follow spontaneous perforation of primary tubercular dacryocystitis. He also observed a nodule of lupus in the cicatrix left after extirpation of such a sac. Stephenson (*Med. Press and Circ.*, Dec. 1, 1909) reports a case of tuberculosis of the lachrymal sac.

Van Lint (*La Clinique Ophtalm.*, Vol. IV, March, 1912, p. 122) reports the successful, non-operative treatment of a case in a girl, aged fifteen years, who had been treated a year previously for a muco-purulent dacryocystitis. Seven months later she reappeared with a fistula of the lachrymal sac, through which an abundance of muco-purulent secretion was being voided. Van Lint made the diagnosis of tuberculous dacryocystitis, and advised removal of the sac. This was deferred for another five months, by which time the edges of the fistula were badly frayed, so that an excision would have resulted in a marked ectropion. Van Lint judged it best to fill the lachrymal sac every other day with Beck's bismuth paste, with the result that in a fortnight the fistula had closed, thus allowing him to operate in sound skin.

Dacryocystoblennorrhea. A mucous or muco-purulent discharge from the lachrymal sac. See **Dacryocystitis, Catarrhal.**

Dacryocystoblennostasis. (Obs.) An accumulation of mucus in the lachrymal sac.

Dacryocystocele. Mucocele or swelling of the lachrymal sac. An obsolete name for a supposed hernia of the sac.

Dacryocystoptosis. DACRYOPTOSIS. (Obs.) Prolapse or downward displacement of a lachrymal sac.

Dacryocystorhinostomy. DACRYOCYSTORHINOSTOMIA. TOTI'S OPERATION. WINDOW-RESECTION OF THE NASAL DUCT (West). This radical operation, which has for its purpose the establishment of a perma-

nent drain from the lachrymal sac to the nose, was devised by A. Toti of Florence, Italy.

The reviewer in the *Ophthalmic Review* for October, 1913, quotes Cirincione (*Clinica Oculistica*, May-June, 1913) as showing that attempts to re-establish an obliterated or morbid passage from lachrymal sac to nasal cavity were first made a very long time ago, in the age in fact of Galen himself, for he proposed to break through via the lachrymal bone and introduce a caustic substance so as to prevent the closure of the new-formed passage.

The milder measure advised by Celsus, the destruction of the sac by means of caustic without an attempt to communicate with the nose, has been preferably followed, and is employed by some to this day in cases of chronic or repeated abscess, or of fistula, and even in cases of mucocele, somewhat to the neglect of Galen's more heroic method.

Even when the anatomy of the parts came to be more carefully studied in the days of Vesalius and Fallopius no new method was proposed for the treatment of abscess of the sac, and indeed it was not till 1700 that probing and irrigation were first recommended. This mode of treatment is largely used by surgeons to this day, and in certain suitable cases may prove successful, but can be of little service when the passage is actually blocked; and in those in which there is no obstacle to the passing of a probe (and there are many such) it is difficult to see what can possibly be gained by catheterization.

Woodhouse long ago proposed to remove the sac and break a passage to the nose, but his suggestion was somewhat neglected at the time. In a number of the cases recourse is had to chloride of zinc paste and other cauterizing and destructive agencies, the anterior wall of the sac being incised to allow of the entrance of the caustic material.

After the operation of removal or destruction of the sac Cirincione has had experience of persistent lachrymation, a result sufficiently troublesome, which he attributes to a prejudicial influence upon the eye as the result of the removal of the sac: this can, of course, be relieved by extirpation of the gland, whether partially or completely. A further annoyance may be the formation of a little cystic sac in the situation of the ablated sac, from which mucus or muco-pus may escape; the walls of this are firm, and cicatricial, and the pseudo-sac thus readily is capable of retaining a more or less septic discharge, and communicates with the outside by way of the canaliculi. In order to avoid this last evil, Cirincione destroys the lining membrane of

the canaliculi with the galvano-cautery. A worse condition of affairs is where the extirpation of the sac has not been quite complete, and a fresh abscess follows as the result of the presence of a portion of the mucous membrane. The reviewer would suggest that certain of these evil results are explicable on the theory that when the sac is excised a cavity remains which at first fills with blood, but into this potential space an outgrowth of membrane may make its way from either nasal duct or canaliculus, unless care is taken by continuous pressure during the healing process to have the whole part consolidated into a firm scar. The surgeon is apt to blame himself quite incorrectly for having left a portion of the sac: the real trouble is nature's misdirected effort to form a new scar.

In 1904 Cirincione first performed on the living subject an operation which he had devised and carried out successfully on the cadaver. He isolated the sac with the canaliculi but preserved them carefully in situ, bored an aperture through the nasal process of the superior maxilla just anterior to the lachrymal ridge, made sure of its freedom of communication with the nose and into the bony canal thus constructed he pushed the lower portion of the sac. In this way he was enabled to form and retain a perfectly sufficient drainage route for the lachrymal apparatus, and the patient was much relieved. He regards this plan of utilizing the mucous membrane of the sac as a lining for the canal artificially excavated through the bone as an element in which his method excels that of Toti. The chief points in which the two operations differ are that he removes the sac and its intraosseous continuation, that he leaves only a small part of the anterior wall just where the canaliculi open into it, and that he makes his new bony canal farther forwards, in the nasal portion of the superior maxilla alone.

According to Bryan (*Annals of Ophthalm.*, July, 1912) the establishment of a new path from the sac into the nose had some vogue from 1840 to 1860, and then fell into oblivion until reintroduced by Auboret in France in 1904, and Toti in 1906, and later by Lagrange.

Modern dacryocystorhinostomy, however, was devised by A. Toti of Florence, Italy, in 1909. (An abstract of one of his early papers may be read in the *Ophthalmic Review* for October, 1909). Toti regards the operation as specially suitable for cases in which repeated abscesses of the sac have occurred and a fistula has formed, and consists, not in the futile attempt to "probe" the old channel, but in the formation of a new and direct one. In the opinion of its author it is a procedure superior to that of excision of the sac. The operation consists in cutting down at the inner side of the orbit, close to

the inner margin of the sac, removing a portion of the inner posterior wall of the sac, turning back the periosteum, and working one's way through the ethmoidal cells to the nasal cavity. A portion of nasal mucous membrane at least equal to the opening in the sac is now removed. It may be necessary in some of the cases to remove part of the turbinated bone before the one can be certain of obtaining a permanent and sufficient tunnel.

The plan has at least the advantage that the drainage of the conjunctiva will be as nature originally intended it, even if the new passage does not exactly correspond with the old in situation. At the time of publishing his pamphlet Toti had carried out his plan in over forty patients and was more than satisfied with the results obtained.

Schirmer (*Zeitschr. f. Augenheilk.*, p. 541, 1909) reported six cases in 1908 on which he performed with good results Toti's operation. He made the usual incision for extirpation of the tear-sac, after which the periosteum at the anterior lachrymal crista and the internal ligament were severed and the sac lifted, with the periosteum, from the bone as far as to the posterior crista. The lachrymal fossa and the nasal wall of the sac were laid bare and large (corresponding) pieces cut out of each. An iodoform tampon was placed in the opening of the bone and carried through the nasal opening; the sac was replaced and the skin sutured. No attention was paid to the nasolachrymal duct.

Of this operation Schirmer has suggested two modifications: Posterior tamponade to avoid aspiration of blood, and the use of Grünwald's forceps, instead of the chisel, for cutting the bone. The catarrh of the tear-sac subsided in the reported cases and an open passage to the nose was obtained. In three cases a slight degree of epiphora remained, which was not to be wondered at, since the normal mechanism for conducting the tears (according to the author's investigations, aspiration from the sac during winking and expression of the aspired liquid by the elasticity of the sac) is destroyed by the operation. Schirmer regarded Toti's procedure as a valuable addition to our operative methods.

Higgens (*Ophthalmic Review*, Mar., 1911) has slightly modified Toti's operation as follows: Turn outwards from the nose a flap carrying the lachrymal sac, excise the inner wall of the sac and clean out the periosteum of the lachrymal fossa, then remove the bone of the fossa; next with a probe inserted through the nose push the nasal mucosa through the hole in the bone and excise the protrusion; replace the skin flap, press into place and suture. The pressure on

the operation site from within and without the nose secures adhesion of the outer wall of the lachrymal sac to the nasal mucosa, and a new track for tear drainage is secured.

R. Salus (*Ophthalmic Literature; Klin. Monatsbl. f. Augenheilk.*, Vol. II, p. 54, 1911) discusses 29 cases operated on in Elschnig's clinic. Discussion of the result comes under the following questions: (1) Does the eye fill with tears as after extirpation of the sac? (2) Is drainage efficient during reflex increase of lachrymation? (3) Is syringing or probing possible? (4) Does a fluorescein solution pass promptly from the conjunctiva to the nose? All requirements were satisfied after the first operation in thirteen, or 45 per cent. of the twenty-nine cases. In eleven cases drainage was inadequate during reflex increase of tears, and fluorescein passed through very slowly or not at all. In the remaining five cases none of the four requirements was satisfied; but pus formation ceased, and the result may therefore be compared to that of extirpation. Five of the cases showing imperfect results came again for operation, and two of these were perfected. The faulty results in the remaining cases were attributed to such technical errors as carrying the opening through into a large ethmoid cell without removing the latter; failure to extend the resection of the lachrymal bone forward into the nasal process of the maxillary bone; inadequate excision of the lachrymal sac, leading to closure of the wound margins; or peculiar anatomic relations. As regards the rapidity with which the conjunctival sac becomes free from germs, Toti's operation is not superior to extirpation of the sac. But for maintenance or restoration of lachrymal drainage no operation equals dacryocystorhinostomy in the prospect of good results.

Bryan (*Amer. Jour. Ophth.*, Vol. 29, p. 122, 1911) describes Fuchs' operation of dacryocystorhinostomy which consists essentially in making a window from the nasal side directly through to the lowest part of the lachrymal sac, without disturbing the dermal surface. The permanent patulousness of the window is questioned by some operators. Török (*Arch. of Ophth.*, Vol. 40, p. 237, 1911) has performed Toti's operation in nine cases, with perfect results in six (no tearing); in two there was moderate tearing chiefly out of doors, and in one the result was equal to extirpation of the sac, no secretion but tearing. Toti (*Ophthalmology*, Vol. 8, p. 553, 1911) claims that his results have improved with experience, and he now has a large number of perfectly cured cases. He states that failure is due to faulty technique, the chief fault being too small a window in the bone; this should not be less than 12 to 15 mm. by 10 to 12 mm. In

a supplementary note to his description of an instrument for perforating the inner wall of the lachrymal sac Gifford (*Ophth. Record,* Vol. 20, p. 50, 1911) adds that the operation was ineffective because of early closure. He also doubts whether Toti's operation will give permanent results, although the covering of the cut edge of the bone with mucous membrane may prevent the rapid formation of granulations from its edge.

West (*Berlin. Klin. Woch.,* 1913, No. 20) and his followers operate intranasally so as to avoid dermal scarring. His procedure is as follows: Under local anesthesia the mucosa covering the lachrymal protuberance is removed and a piece of the ascending ramus of the maxilla and lachrymal bone chiseled away. The interior turbinæ is not disturbed. After exposure of the sac the nasal wall is excised and direct artificial communication made between the eye and nose above the intact lower turbinate. In 90 per cent. of the cases, which included epiphora, dacryocystitis, dacryoblennorrhea, phlegmonous dacryocystitis and lachrymal fistula, excellent results followed.

Bogorad (*Viestnik Ophth.,* Vol. 29, p. 739, 1912) describes Schimanowski's modification of Toti's operation for dacryocystorhinostomy, which should be done only when the sac is patulous. Only that portion of the bone entering into the formation of the lachrymal fossa and the frontal process of the superior maxillary bone should be removed, together with the nasal mucous membrane and the lateral wall of the tear sac.

Yankauer's (*Laryngoscope,* Vol. 22, p. 1331, 1912) technic for his intranasal operation upon the lachrymal apparatus for the relief of chronic dacryocystitis is as follows: Temporary elevation of the mucous membrane of the outer nasal wall, resection of the bony wall of the duct, slitting open the entire membranous canal from below its nasal orifice up to and including the sac, thereby dividing all strictures, destroying the venous plexus surrounding the canal and evacuating the pus and finally replacing the mucous membrane of the outer nasal wall. The result of the operation is the enlargment of the bony membranous passages and the reestablishment of drainage in the manner originally designed by nature. See page 1917, Vol. III, of this *Encyclopedia.*

See, also, **Lachrymal apparatus, Diseases of the.**

Dacryocystosyringokatakleisis. An almost forgotten operation devised by Dieffenbach for the cure of lachrymal fistula. It consisted in paring the edges of the opening, dissecting up the skin around the

fistula, and uniting the wound edges by sutures, assisting the sliding of the skin-flaps by lateral incisions through the skin.

Dacryocystotome. An instrument for cutting or piercing the lachrymal sac.

Dacryocystotomy. Surgical puncture of the tear-sac.

Dacryohæmorrhea. Dacryohæmorrhysis. Dacryæmorrhysis. Obsolete terms employed to define "bloody tears."

Dacryoid, adj. Resembling or having the form of a tear. Pointed at one extremity and rounded at the other, like the seeds of pears.

Dacryoides. Dacryoid, or tear-shaped.

Dacryolin. An organic substance found in the lachrymal fluid. It is not coagulated by acids or by heat, but by slow evaporation in the open air is converted into a yellow, insoluble substance.

Dacryolite. Dacryolith. A calculous concretion in the lachrymal apparatus; tear-stone, or lachrymal calculus.

Dacryolith. Tear-stone. Dacryolite. Lachrymal calculus. A chalky concretion of the lachrymal gland. According to Power, in a case of a tear-stone examined by Curtis, it was found to be composed of 28.3 parts of organic matter and 71.7 of calcium phosphates. The organized portion of the dacryolith is generally made up of the streptothrix Fœrsteri and other fungi. Sometimes the lime salts are deposited around a cilium. These extremely rare formations may cause considerable irritation and should be removed, preferably through an incision at the upper conjunctival cul-de-sac.

Dacryolithiasis. (L.) The formation of concrements in the lachrymal passages.

Dacryoma. A lachrymal tumor. R. A. Vogel by this term has described that condition of the *puncta lachrymalia* by which the tears are prevented from passing into the nose, and an epiphora is produced.

Dacryon. In *anatomy* (in the determination of the orbital index), the point at which the lachrymal, frontal and inferior maxillary bones touch.

In *physiology,* a tear, or the lachrymal secretion.

Dacryonome. (Obs.) A corroding ulcer of the lachrymal passages. Improperly, epiphora.

Dacryopé. (F.) Causing a secretion of tears.

Dacryopericystitis. Prelachrymal abscess. Tumefaction as a result of inflammation of the tissues about the lachrymal sac—generally secondary to a purulent dacryocystitis, which must be treated in conjunction with the extra cystic sequel. This consists mainly of free opening of the sac and packing of the entire cavity; energetic cau-

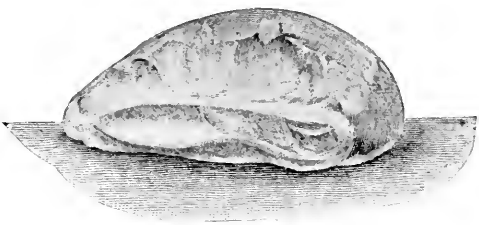
terization of the pericystic cavity, and milder applications of the same to the mucous membrane of the sac, with direct probing of the canal. The cavity is allowed to heal from the bottom by granulations. Inveterate lachrymal fistulas are treated by laying open the fistulous tract from the cutaneous opening into and including the sac, cauterization, and packing of the wound to secure healing from the bottom.

Dacryopoeus. Dacryopoios. (Obs.) Causing lachrymation.

Dacryops. This term, introduced by Schmidt in 1803 and intended to define a cyst or cystoid degeneration of one of the ducts of the lachrymal gland, is a rare affection. Rogman (*Annales d'Oculistique*, Jan., 1899, p. 1) collected, to date of writing his memoir, twenty-four, and zur Nedden (*Klin. Monatsbl. f. Augenheilk.*, April, 1902) thirty-three cases. The latter has added two more instances to those previously reported.

According to Parsons (*Pathology of the Eye*, p. 751) cysts of the inferior lachrymal gland—dacryops proper—are rounded, more or less transparent, superficial swellings, situated at the outer angle of the upper *cul-de-sac*. They may be flattened (Francke), or lobulated (de Wecker). They vary in size from a pea to a pigeon's egg. The conjunctiva is freely over them. If sufficiently large, fluctuation can be demonstrated, and the fluid can occasionally be pressed out through minute openings or through a definite fistula. Variations in volume of the same tumor may be noted occasionally. Dacryops has been examined microscopically by Legros, Francke, Lagrange, Ahlström, and others. In Legros' case the cyst was lined with cylindrical epithelium resembling that of the lachrymal ducts. Francke also found a single layer of epithelial cells; he noted specially normal ducts which were constricted in places; similar structure was found by Lange and Rogman (2 cases). Lagrange found a single layer of cylindrical epithelium lining the cyst. Sourdille found a single or double layer of cubical epithelium, or flattened endothelioid cells lining different parts of the cyst; Ahlström's case was similar. The fluid contained in the cysts is more or less altered lachrymal secretion, colorless, or in the older cysts slightly yellow; it has been analyzed by Broca, and by Badal and Aubaret. It contains sodium chloride and proteid material, with traces of sulphates and fats: cholesterin, epithelial cells, and leucocytes—mostly polymorphonuclears—may also be present: there is no mucin. These data tend to show that the cases examined were retention cysts. The cause is usually some injury involving the ducts, *e. g.* incomplete extirpation of a dermoid (Beer), a burn (Broca). Francke considers that there is

inflammatory sclerosis around the ducts. It is possible that there may be an ascending infection from the conjunctiva (Sourdille), but in Badal and Aubaret's case the contents were sterile. Cysts of the orbital gland are probably due to definite neoplasms. It is a curious fact that concretions, similar to those found in the salivary glands, have not been observed in relation with dacryops. They are, indeed, rare, but a case has been reported in connection with an otherwise normal lachrymal gland by Levi. See, also, **Cysts of the lachrymal gland.**



Dacryops. (After Lawson.)

E. Thomson (*Ophthalmoscope*, Vol. IX, p. 396, 1911) observed a translucent, bluish-gray swelling between the upper lid and eyeball in a child of 7½ years. Upon eversion of the lid, the growth did not prolapse but seemed to extend backward. The swelling, typically cystic in appearance, occupied the fornix pretty nearly from the outer to the inner canthus. At the operation, which was performed through the upper cul-de-sac, the cyst collapsed discharging a jet of limpid fluid. As large a piece as possible of the cyst wall was excised. Microscopic examination showed that the cystic structure was more or less surrounded by small masses of gland tissue, altered in character by the combined pressure of the cyst and fibrous tissue, which latter gave evidence of inflammatory reaction.

Thomson thinks that dacryops is a cystic dilatation of one or more ducts of the main lachrymal gland or of the accessory gland of Rosenmüller, and that these glands themselves may in some cases be involved in the cystic process. However, the cause of this rare condition still remains obscure. Zur Nedden came to the conclusion that the reported cases fall into two groups: first, pure retention cysts; and second, dilatation of the duct, in consequence of catarrhal inflammation of its mucous membrane with consequent weakening of the wall.

The *treatment* is simple removal, but the skin must be respected, otherwise a fistula is the probable result.

Dacryops fistulosa. Lachrymal fistula.

Dacryoptosis. Dacryocystoptosis. (Obs.) Prolapse of a lachrymal sac; also, lachrymation or shedding of tears.

Dacryopyorrhea. Purulent discharge from the lachrymal apparatus, especially from the puncta.

Dacryopyosis. Suppuration of the lachrymal passages.

Dacryorrhea. Dacryorrhysis. Dacryrrhea. Excessive secretion or discharge of tears. Lachrymation.

Dacryosolen. A lachrymal duct or canal.

Dacryosolenitis. Inflammation of a lachrymal duct or ducts.

Dacryostagia [Benedict]. Dacryostagma. Dacryostagon. A continual dropping of tears. Epiphora.

Dacryostagme. (F.) A continual dropping of tears.

Dacryostenosis. Stenosis or stricture of the naso-lachrymal duct.

Dacryosyrinx. A lachrymal fistula. Also, a syringe for use in the lachrymal ducts.

Dacryrrhea. Dacryrrhysis. An excessive secretion of tears; lachrymation. Its unilateral occurrence has been observed by Féré in a case of locomotor ataxia. (Foster.)

Dacryuria. (L.) An obsolete term to indicate a supposed secretion of tears in the urine. The involuntary flow of urine in hysterical and nervous persons while they are weeping.

Dactylitis. This inflammatory enlargement of the small joints is worthy of mention here mainly because it is sometimes an accompaniment of certain eye diseases due to a general infection—such as phlyctenular disease of the eye from gout, scrofula, tuberculosis, etc.

Dactylograph. An instrument with a key-board designed to convey by the touch the signs of speech and words to blind deaf-mutes, or to the blind conversing with deaf-mutes.

Dædaleum. An instrument (similar to the discs of Uchatius and Johannes Müller) devised by W. G. Horner as an anorthoscope. The openings are made in the top, or crown, of a hollow cylinder, and the images are made partly upon the inner surface of the crown, which should be transparent, and partly upon the bottom. See Vol. I, p. 503, of this *Encyclopedia.*

Daguerreotype. An early form of photograph made on a surface of silver sensitized with iodine and developed by mercury.

Dahlfield, Stereoscopic figures of. See **Stereoscope.**

Dakry—A few observers retain in English the Greek (and German) form of Δαχρυς and write the foregoing heading for **Dacry—**, to which prefix readers are in each instance referred.

Dalbey, James William. A prominent ophthalmologist of Iowa. He was born in a log cabin in Logan County, Illinois, Oct. 23, 1863, the son of John W. Dalbey, a farmer and livestock dealer. His mother, before her marriage, was Hannah E. Kincaid.

He entered Illinois College, at Jacksonville, Ill., taking the scientific course, in which he was graduated in 1885. On this occasion he was class orator.

While a student in Illinois College he became acquainted with Dr. A. E. Prince, now of Springfield, Ill., but at that time conducting, together with his father, a sanitarium at Jacksonville. The acquaintance ripened into warm friendship, and, because of the influence of "Doctor Arthur," young Dalbey determined to study medicine.

At first he took two courses of medical lectures at the University of Michigan, then proceeded to New York, where he took a supplementary course and received his degree in 1888.

Serving for the following eighteen months as assistant to Dr. A. E. Prince, at Jacksonville, he then removed to Cedar Rapids, Iowa. Here, though a total stranger at the outset, he soon had an excellent practice. For fifteen years he was a partner of Dr. Frank Carroll.

On the recommendation of Drs. John Rauch, David Prince, and George N. Kreider, he was appointed Lecturer on Ophthalmology and Otology in the Medical Department of the State University. Two years later he was elected full professor, and in 1902 Professor Emeritus.

He was twice elected delegate to the American Medical Association from Iowa.

He married, Oct. 30, 1889, Miss Fannie B. Dayton, at Jacksonville, Ill. Of the union were born three children: Dayton Elmer, Harry Kincaid, and Allen Kreider Dalbey.

Dr. Dalbey was a republican, but not a politician. He was a member of the Presbyterian church, and an active worker in that institution. He was a member of the Occidental Club, of Cedar Rapids.

An extremely amiable man, he was loved and honored by the profession and the laity alike.

He died very suddenly March 4, 1908, at Springfield, Ill., of diabetic coma.—(T. H. S.)

Dalrymple, John. One of the best known British ophthalmologists of the early nineteenth century. He was born in 1804, became Assistant Surgeon to the Ophthalmic Infirmary, London, and later was appointed Instructor in Surgery at Sydenham College. He wrote a remarkable "*Anatomy of the Human Eye*" (5 plates, London, 1834), and a "*Pathology of the Human Eye*" (36 folio plates, London, 1852), both of which long continued to be authorities on the subjects treated. He is said to have been a skilful operator and an excellent microscopist. He gave his name to Dalrymple's sign, in exophthalmic goitre. He died May 2, 1852.—(T. H. S.)

Dalrymple's sign. This is found in Graves' or Basedow's disease (q. v.). It consists of abnormally separated lids and much increased interpalpebral space, giving a staring expression to the face of the patient. It is not pathognomonic of Graves' disease, being not infrequently observed in health. The phenomenon is due to retraction of the lids by contraction of the non-striated muscle fibres of the lids and orbit consequent on stimulation of the sympathetic. See **Exophthalmic goitre.**

Daltonian. Pertaining to John Dalton, an English chemist (1766-1844). A color-blind person.

Daltonism. Color-blindness received this name from the fact that the English chemist, John Dalton (q. v.), suffered from it, and was probably the first to study his color-sense by the spectrum. Describing his own case in 1794, he said he became convinced of its existence from his observations of a pink geranium by candle-light. "The flower," he says, "was pink; but it appeared to me almost a sky-blue by day. In candle-light, however, it was astonishingly changed, not having any blue in it, but being what I call a red color, which forms a striking contrast to blue." See **Color-sense and color-blindness.**

Dalton, John. Founder of the atomic theory of chemistry, and discoverer of the so-called Daltonism, or color-blindness. He was born in September, 1766, at Eaglesfield, near Cockermouth, Cumberland, England. At the age of twelve he was teaching school. At fourteen and fifteen he was working on his father's farm. In 1781 he removed to Kendal, where he became assistant to his cousin, George Bewley, who was master of a school for boys and girls at that place. During all this time he studied Greek, Latin, mathematics, and, especially, natural philosophy.

His most important writings are: "Meteorological Observations and Essays" (1793); "Elements of English Grammar" (1801); "Extraordinary Facts Relating to the Vision of Colors" (in *Memoirs of the Literary and Philosophical Society of Manchester,* Vol. 28, 1798).

The last-named article—though written by a man who was not even a physician—is one of the immortal classics of ophthalmology, because therein is presented, for the very first time on record, an account of the so-called color-blindness—an affection which now "rejoices" in as many appellations as there are colors in the spectrum, and more (e. g., Daltonism, dyschromatopsis, chromatopseudopsis, parachromatism, etc., etc.).

An interesting story is related of one of the ways in which young

Dalton's attention was directed to the very important subject of Daltonism. As a mere boy he happened to be present at a review of troops. Hearing those about him remarking on the beautiful military costume, he enquired "in what the color of the soldier's coat differed from that of the grass on which he trod?" The laughs and derisive shouts which greeted this extremely earnest request for information set Dalton to thinking and experimenting. He found himself unable to distinguish more than three of the spectrum colors: blue, purple, and yellow. "That part of the image which others call red, appears to me little more than a shade or defect of light; after that, the orange, yellow and green seem one color, which descends pretty uniformly from an intense to a rare yellow, making what I should call different shades of yellow."

In 1833 the Government conferred upon Dalton an annual pension of £150, which, three years later, was raised to £300. A bust in his honor, which cost £2000, and which came from the hand of Chantrey, was placed in the entrance hall of the Manchester Royal Institution. In 1834 he received from the University of Edinburgh the degree of LL.D.—the only degree that was ever conferred upon him.

In April, 1837, he was stricken with paralysis. In the spring of the following year he received a second stroke, and, two years later, a third. On the morning of May 27, 1844, he fell from his bed, and was found lifeless by his attendant. He was buried in Ardwick Cemetery, near Manchester.—(T. H. S.)

Dam. Local immersion treatment. Rubber dam. Coffer dam. In ophthalmology these terms are sometimes employed to describe the means by which liquid applications to the external eye are kept for a considerable time in contact with diseased parts.

That the medicament may remain for as long a period as seems necessary when instilled into the conjunctival sac, several devices have been invented. Among these is the making of a dam to stretch from the nose along the orbital margin to or beyond the external canthus. The patient should lie on his back and the dam, made of rubber, clay or other material, retains the collyrium poured into the space thus fashioned until it overflows and thoroughly covers the front of the eye. Myles Standish, as well as other surgeons, employs this means for the application of argyrol and similar agents for periods varying from five minutes to half an hour. Additional effect is obtained by having the patient "wink" the fluid well into the eye during this time.

Aside from other treatment of inflammation of the lids, lachrymal apparatus and uveal tract, E. E. Holt uses a dam about the orbital

margin, of putty, cotton-batting or rubber cloth. The patient lies down, the cavity thus made is filled with hot normal salt solution, and the patient winks in the fluid until it becomes cool. This expedient facilitates the resolution of the inflammation, the exudates clear up and the parts are materially assisted in regaining their normal function.

Damages. Monetary compensation for a damage. Damages are of three great classes: *Nominal, substantial* or *compensatory;* and *punitive, exemplary* or *vindictive. Nominal* damages are those awarded when there is a mere technical violation of a right, but no actual damage. *Substantial,* or *compensatory,* damages are allowed when there is not merely a technical violation of a right, but also an actual damage, or injury. *Punitive, exemplary,* or *vindictive* damages may be recovered—in certain jurisdictions only, and these not many—when the damage was inflicted under aggravating circumstances. See, also, **Economics of the eye**; as well as the **Legal relations of ophthalmology.**

We are indebted for the following abstracts to the *Ophthalmic Year-Book:* The determination of the proper compensation for impairment of vision arising from injury, especially from accidents of labor, is an extremely complex problem. It is often very difficult to determine the actual facts of the particular case, and it is equally difficult to reach a conclusion as to the general considerations that should influence our judgment. Terson (*Ann. d'Oculist.,* Vol. 142, p. 379, 1909) with this in mind discusses the medico-legal importance of temporary opacities of the crystalline lens. Some of these may be quite fleeting, as the ring-shaped traumatic opacity of the anterior surface. Others clear up more slowly but completely, as those from slight punctures of the lens under complete mydriatic rest. Others clear up partly, permitting improved but not perfect vision. The prognosis will be influenced by age and general condition of health, as well as by treatment. He points out the importance of avoiding the term cataract, in speaking of these cases to the patient or to a jury; or if used, the qualifying of it by such terms as "temporary" or "partial" cataract.

On the other hand, traumatic cataract may appear after a considerable interval has elapsed since the injury, and may go on to become complete. Dor (*La Clin. Ophtal.,* 1909, p. 452) records a case of electrical injury, in which partial cataract developed some time after the shock, reducing vision to ⅛th of normal; and he cites other cases in which the interval was from six weeks to three years. He thinks that late cataract, consecutive to hemorrhagic iridocyclitis immediately

following the injury, is sufficient to establish a connection with the electric shock.

Dehenne and Bailliart (*Bull. Soc. Française d'Ophtal.*, 1909) have discussed the share of predisposition in producing a lesion which follows injury, as in a highly myopic eye which shows detachment of the retina after a slight blow; or where parenchymatous keratitis follows moderate trauma, in a person who has an hereditary taint of syphilis or a gland tuberculosis. Such factors are of great practical importance, quite apart from any actual lesion that the eye may have presented before the accident occurred.

In the individual case the tendency to exaggerate the visual disability always needs to be guarded against. Thus, in a case reported by Charles (*Am. Jour. of Ophth.*, p. 292, 1909) the patient seemed to believe herself blind in one eye, and showed great contraction of the visual fields. But after tests for simulation had shown that the eye could see, its vision was brought up to more than $7/10$ of normal. On the other hand, it is possible for a claimant for compensation for visual damage to have suffered a lesion of which he remains unconscious. In Dor's case, mentioned above, the measurement of the visual field of the right eye, which was supposed to have escaped injury, showed a sector defect involving one-eighth of the field, most reasonably explained by damage to the optic nerve by the electric current.

Baudry (*Arch. d'Opht.*, p. 273, 1909) has made a study of the subject, paying especial attention to the effect of partial opacities of the cornea central and paracentral. In these cases the impairment of vision is likely to be exaggerated; and yet it is known that the irregular refraction and diffusion of light by a damaged cornea may interfere more with the usefulness of the eye than the result of trials with test letters might indicate. Baudry thinks that when there seems to be exaggeration of the disability, a just conclusion may be reached by comparison with other cases of apparently equal damage to the cornea, in which the true acuteness of vision and capacity for labor are known. To this end he summarizes some 37 cases of central and paracentral corneal leucomas, 20 cases of trachomatous keratitis, miscellaneous cases with blindness of one eye, and aphakia, to the total of 76. He holds that the French law is wrong in fixing 33 per cent. as the disability from loss of one eye. For many trades the disability entailed is much less than this. It would be liberally estimated at 20 per cent.; while for persons engaged in work requiring accurate binocular vision the damage may be fully 40 per cent. of the earning ability. It is also a mistake to consider a patient blind when vision is reduced to $1/10$ or $1/15$; because some with vision of $1/20$ are

enabled by it to do the work that brings a low grade of compensation.

Ricchi (*Ann. di Ottal.*, Vol. 38, p. 528, 1909) points out that the assessment of damage for injury is a medical question. But while we know the functions of the human body, we still lack information as to the effect of the impairment of these functions upon different kinds of labor. He distinguishes between functional incapacity that he terms intrinsic, and that which he calls relative; the former being loss of function as measured by scientific standards, the latter disability in relation to the particular occupation. In different occupations relative incapacity would be very differently influenced by lowered central acuity, impairment of the visual field, loss of accommodation or impairment of movement; and there still remain questions of sympathetic ophthalmia, the condition of the eye before injury and the influence of treatment, including operations. These and other factors are carefully considered in Evans' review of recent literature concerning eye injuries in their relation to the Workmen's Compensation Act. Evans (*Ophthalmoscope*, p. 403, 1909) begins by pointing out that in expert testimony the surgeon's personal opinion as to the humanitarian and equitable aspects of the case must be subordinate to the legal point of view. Barazza (*Tr. 11th Int. Cong. Ophth.*, Naples, 1909) reviews this subject and points out the need for special laws with reference to industrial injuries. Percival (*Tr. 11th Int. Cong. Ophth.*, Naples, 1909) presents formulas for the calculation of damages for ocular injury, and tables for estimating the loss of earning capacity. Holt (*Tr. Am. Ophth. Soc.*, p. 141, 1909) again presents his formula and illustrates its use by application to different conditions, and by tables showing the variations in damages produced by variations in the different factors.

Fergus (*Brit. Med. Jour.*, Sept. 25, 1909) thinks the problem of compensation for eye injuries is all but insoluble. At any rate, there is not at present sufficient data. He quotes the statement of the mathematician, Professor Tait, that it is quite impossible to formulate anything which involves human volition. He knows one blind man who can scarcely find his way to the house next door; and another who plays an excellent hand at whist and gets out on the leads of his house to shovel off snow. Fergus believes that in very few occupations is binocular vision essential, and supports this view with many instances. He thinks that claims for damages can be best decided by a good medical referee, and believes that such should be specially retained, paid a proper salary, and allowed to do no other kind of practice. De Lapersonne (*Presse Medicale*, July 24,

1909) has also written upon the final incapacity from the traumas of the eye.

Johnston (*Ophthalmology*, Vol. 5, p. 606, 1909) thinks the majority of eye injuries might be prevented by government inspection of the manufacturing of explosives, licensing of men who use them, protection of water and oil gauges by wire or plate-glass screens, guards for emery wheels, lathes, etc., and education of the laity as to the seriousness of even slight injuries when infected.

Walters (*Klin. Monatsbl. f. Augenheilk.*, Oct., 1910, p. 522) discusses the inconsistencies of the German courts concerning the inclusion or not of certain occupations in the category of so-called "qualified laborers"; and also as to the extent to which monocular vision can in time replace binocular vision, and the effect of this consideration on a reduction of compensatory allowances. Buning (*Med. Rev.*, p. 303, 1910) relates three cases in which, against the advice of ophthalmologists, the special court dealing with these matters in Holland decided that the training of monocular vision had compensated for binocular vision, and reduced the allowances previously made. Van Geuns (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 349, 1910) considers the basis of visual acuity existing in each eye two years after injury as affecting the estimation at that time of further allowances to be made.

Van der Heyde (*Arch. d'Opht.*, Vol. 30, p. 255, 1910) thinks the scale of compensations for many ocular injuries, including the loss of binocular vision, is excessive. Bijlsma (*Geneesk. Cour.*, Vol. 64, No. 21, 1910) writes on clouding of vision and on disability from loss of one eye. Roca (*Arch. de Oftal. Hisp.-Amer.*, Vol. 10, pp. 402 and 751, 1910) has tabulated statistics of 500 ocular labor accidents. They were 8 per cent. of all labor accidents; and 96.6 per cent. of them occurred in the male sex, 68 per cent. involved the cornea, 12.2 per cent. the sclera, 5.6 per cent. the lids, and 5 per cent. the anterior chamber. In 78.4 per cent. of the accidents the traumatizing body was iron. The operation most frequently required was extraction of the lens. Of the operations 77.4 per cent. were extraocular and 14.8 per cent. intraocular. Of 253 ocular injuries among metal workers investigated by Truc (*Ann. d'Ocul.*, Vol. 144, p. 435, 1910), he estimates that 213 could have been avoided by the use of spectacles. Nuel (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 525, 1910) urges that extirpation of the tear sac should be done in all laborers with disease of the lachrymal passages who are exposed to corneal injury.

Articles appear by Bourgeois (*Union Med. du Nord-est.*, Vol. 34,

p. 53, 1910) on operations for traumatic cataract due to labor accidents; by Evans (*Med. Rev.*, Vol. 69, p. 127, 1910) on the estimation of the visual efficiency of injured workmen; by Gallenga (*Rivista Ital. di Ottal.*, Vol. 6, p. 168, 1910) on the eye and vision in relation to occupational diseases, and by Wintersteiner (*Wien. Med. Woch.*, Vol. 60, p. 1257, 1910) on injuries to the eyes of workmen.

Chevallereau (*Ann. d'Ocul.*, Vol. 143, p. 387, 1910) saw four cases in which after a blow on the eye there developed pigment patches, such as might give rise to an erroneous diagnosis of chorioretinitis. The differentiation was made by their not being generally distributed, and being always found in the lower part of the fundus. They are probably due, not to hemorrhage, but to migration of retinal pigment. An insurance company having disputed the claim of an insured male nurse for compensation for a gonorrheal ophthalmia contracted from a patient, the German court gave judgment for the claimant. Four cases of parenchymatous keratitis observed by Antonelli (*Arch. d'Opht.*, Vol. 30, p. 561, 1910) were directly excited by slight trauma of the cornea in congenitally syphilitic patients. They were all limited to the traumatized eye, and he thinks such cases should be compensated. He is skeptical, however, as regards the occurrence of sympathetic keratitis in such circumstances.

In Armaignac's case (*Recueil d'Opht.*, Vol. 32, p. 215, 1910), the contact of a drop of metal solder with the cornea was followed by parenchymatous keratitis, first in the same and then in the other eye. The patient was apparently free from luetic taint, but before the second eye was well he developed a severe attack of articular rheumatism. The vision of the second eye was permanently diminished, but the patient was disposed to claim compensation on the ground that both eyes had been affected as the result of the burn. The author raises the question whether the rheumatism and the corneal disease were not related to one another.

Immature senile cataract had been removed from both eyes of a man of 58 years whose case is reported by Sandmann (*Klin. Monatsbl. f. Augenheilk.*, Sept., 1910, p. 398). Although both eyes presented myopia of about 20 D., vitreous opacities and macular choroiditis, recovery was perfectly normal. Six years later the patient lifted from the ground an unusually heavy weight, and retinal detachment resulted in the right eye. The author's opinion was that the detachment was due to the strain of lifting; but the court adjudged the ocular injury to be neither a direct nor an indirect result of the bodily effort. The same judgment was given by a second expert; and

the claim for compensation was therefore disallowed. The author reviews the medico-legal records of analogous cases.

In the case reported by Räcke (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 534, 1910), corneal herpes zoster, leading to loss of vision, developed a few days after a blow on the eye. The lower court refused compensation on the basis of the expert's opinion that an etiologic connection between the blow and the herpes was possible but not probable; but a higher court assumed a probable connection and allowed the claim.

Seidenmann (*Centralbl. f. p. Augenheilk.*, Oct., 1910, p. 293) describes three forms of ocular injury intentionally produced in Russia for the purpose of avoiding military service. They usually relate to the right eye. Sometimes an opacity is produced in the pupillary region of the cornea. In other cases cataract is produced by thrusting a needle several times through the centre of the cornea and into the lens; some of these eyes are completely lost from secondary glaucoma. Rarely the sight has been completely destroyed by allowing a leech to suck the aqueous humor through the cornea, with resulting intraocular hemorrhage and retinal and choroidal detachment. Other cases of the same class are described by Günther (*Münch. Med. Woch.*, Vol. 57, p. 638, 1910). An article on vision appears by MacDermott (*Med. Press and Circ.*, Oct. 19, 1910).

Damian. A physicist of the Greek middle ages, concerning whose personality very little is known. He is supposed to have flourished in the 5th century, but even this is not certain.

However, he wrote (in Greek) a work on optics which is one of the most important still extant from the early Christian centuries. In this work he first enunciated the following elementary principles, or axioms, which he then proceeded to amplify:

1. We are enabled to see by means of certain rays, or emanations, which pass out from our eyes and strike upon surrounding objects.
2. That which passes out from us, is "light."
3. This outstreaming light moves in straight lines.
4. And indeed in the form of a cone.
5. This cone is right-angled.
6. The cone is not equally filled with light in all its parts.
7. All objects are seen either under a right, or under an acute, angle.
8. For which reason, things that are seen under a wider angle than usual appear to be larger than normal.
9. We see distinctly almost alone with the axial portion of the light-emanation.

10. The visual power operates, by nature, chiefly in a forward direction.

11. The point of the visual cone, within the eye, lies more to the inner side than does the pupil, and forms the centre of the surface of a sphere from which the circumference of the pupil cuts off (apotemnetai) ¼.

12. We see all visible objects either by a rectilinear expansion of our visual radiation or by a reflection or refraction thereof.

13. Concerning the relation of our visual organ to the sun.

14. In cases of reflection our visual rays form equal angles with the reflecting surface. The same thing is true concerning the sun's rays.

An excellent German translation of this work of Damianus (as well as of extracts from Geminus) was made by Richard Schöne, which, together with the original texts, was published in Berlin in 1897.—(T. H. S.)

Damianos. German form of the Latin Damianus. The English is Damian (q. v.).

Damianus. The Latin for the German Damianos. The English is Damian (q. v.).

Damier hyperbolique de Helmholtz. (F.) The "checker-board" figure of Helmholtz.

Dampfbad. (G.) Vapor bath.

Dandolo, Enrico. Doge of Venice (the first of his name to reach that high estate) and Prince of Bohemia, the "blind old Dandolo" of Byron's *Childe Harold's Pilgrimage.* He was born A. D. 1108, nephew of the patriarch of Grado. When a very young man, he visited Constantinople, where he was arrested as a spy, and, according to some accounts, was blinded by order of the Emperor, Emanuel Comnenus of Constantinople, who subjected him to what was known as "abbasination." This consisted in compelling the victim to gaze for a long time into a polished basin, usually of brass, the concavity of which, catching the rays of the sun, concentrated these into the eyes of the victim. The pain produced by such an exposure is said to have been so great that many of the subjects of the punishment went not only blind but insane. According to the accounts of other writers, however (e. g., that of Villehardouin) Dandolo was blinded by a wound.

At the advanced age of eighty-four (namely, in 1192) Dandolo was elected Doge, or Duke, of the Venetian republic, and commander-in-chief of the Venetian army and fleet. This office he held for thirteen years. While still in power (1201) Dandolo was applied to

by the French crusaders for assistance in their expedition to Palestine. The shrewd old blind ruler, it is true, granted the use of his galleys, and also provided arms, provisions and money; but, in return, he insisted that, in lieu of a money rental, the French should make an expedition, with him at the head, against Zara—a city which had recently revolted against Venetian rule. These terms, at first demurred to, were finally accepted. Cross in hand, then, this long blind nonagenarian assumed the command of the fleet. And Zara fell.

About this time there came to Dandolo, asking for help for the sender's father, a message from Alexis, son of Isaac Angelus, who, once Emperor of the East, had been deposed and blinded. Dandolo listened to the messenger's entreaties, and then once more, so powerful was the old Doge's eloquence, he persuaded the crusaders once again to postpone their expedition to the Holy Land, and to join him in a war against Constantinople.

Arrived before the capital of the East with five hundred ships, the Venetians and the crusaders found the harbor closed against them by means of an enormous chain. Once again, Dandolo was equal to the emergency. He had brought with him a pair of colossal scissors, by means of which the obstruction was rapidly divided. Constantinople was at once attacked, and the first to land, "by means of a drawbridge let down from the higher yards to the walls," and to enter the city, was Dandolo, the blind, who was then actually 97 years of age. And the city he was entering, furthermore, was the very one in which, long years before, he had been subjected to abbasination.

The blind old fighter then proceeded to restore the blind old emperor to his former position and prosperity.

At the death of Isaac, Dandolo was remembered to such an extent that he was offered the dominion of the entire East. This temptation, however, he promptly rejected. Being then urged to accept the crown of a portion of Romania, he did so, and ruled with justice and moderation.

He died June 1, 1205, aged 97, one of the greatest men in history. —(T. H. S.)

Dandy fever (dengue), Ocular manifestations in. This tropical, epidemic disease resembles remittent fever, but is much more severe. The symptoms are deep pain in the head and eyes, pain in the back and joints, catarrhal inflammation of the mucous surfaces—especially those exposed to the air—swollen salivary glands, and a skin eruption resembling measles. In addition to a congested conjunctiva other ophthalmic symptoms have been observed. Among these are photo-

phobia, itching and deep redness of the lids, paresis of accommodation, anesthesia of the retina, keratitis and iritis. Vernani has described a hyperesthesia of the retina, which gave rise to yellow or yellow-red vision. The pains throughout the body are probably the result of muscular soreness and this will explain the discomfort experienced by the eyes of patients suffering from dengue during slight movements of the eyeball.

Dane's blood. See **Pulsatilla.**

Danger signals. Whatever prevents accidents on railroads is of great value to the public. The number of industrial accidents is very large, recent statistics showing that approximately one worker is killed every fifteen minutes of every twenty-four hours of each three hundred and sixty-five days of the year, and another injured every fourteen seconds of every day. The necessity of decreasing this sacrifice of life and limb is self-evident, even from mere commercial considerations, for it represents a loss to the community at large, a total of over $250,000,000 a year.

Experience has shown that mechanical safeguards alone will reduce the number of industrial accidents by approximately 33 per cent. but there are many accident hazards which cannot be guarded against by a mechanical safeguard, and so it becomes necessary to call the attention of all employees to these dangers by some special and forceful form of danger signal.

This subject will be further considered under **Employees, soldiers and sailors, Examination of the eyes of.**

Danger zone. This term has been applied to that portion of a zone, one-quarter of an inch wide, surrounding the cornea, because it is in this region that perforating wounds are especially liable to produce acute or chronic cyclitis and sympathetic inflammation.

Daniel Ibn Saja. An Arabian ophthalmologist of the Middle Ages, whose name is mentioned in Halifa's *Book of Sufficiency in Ophthalmology* in connection with a commentary on Ali ben Isa. Nothing else is known about him.—(T. H. S.)

Daniell. A unit of electric measurements equal to 1.124 volts.

Danse de Saint-Guy. DANSE DE ST. WYT. DANSE CONVULSIVE. (F.) ST. VITUS' DANCE. Chorea.

Daphne mezereum. The only instance known to the Editor of eye symptoms produced by this laxative is that mentioned by Lewin and Guillery (Vol. 2, p. 953) wherein forty berries of the plant produced poisonous symptoms associated with mydriasis.

Dard. (F.) Sting of insects.

Darier's disease. Keratosis follicularis. This rare disease begins on the face or trunk, and involves the lids. It appears as a papule the size of a lentil or pea, of a dirty-red color, having a brown, black or gray horny crust, which plugs a sebaceous duct. It is a rebellious affection, and should be referred to a dermatologist for treatment—(J. M. B.)

Dark-adaptation. Although this subject (the adaptation of the retina to the new conditions imposed by the exclusion of light) has already been discussed (see Vol. IV, p. 2361 of this *Encyclopedia*) yet it seems desirable to give here a few additional observations. Horn (*Arch. f. Augenheilk.*, Vol. 59, No. 4, 1908) has tested dark-adaptation in various fundus changes. In myopia, even high degrees, he finds it is not altered. Where it is disturbed this disturbance must be ascribed to the accompanying choroidal changes. In cases of congenital amblyopia there was a marked departure from the normal, which was particularly well demonstrated in squinting eyes. The disturbance of adaptation, both as to amount, time and character, was marked in the hemeralopia of chronic alcoholism, nephritis, diabetes without ophthalmoscopic changes, atypical retinitis pigmentosa, hereditary syphilitic chorio-retinal changes, and tabetic optic atrophy. Severe choked disk or detachment of the retina can occur without disturbance of adaptation. But glaucoma lowers it, and this may be an early symptom. Choroiditis, recent or old, and commotio retinæ affect it. In color-blindness adaptation seems not to reach the normal.

H. M. Traquir, reviewing (*Ophthalmic Review*, Aug., 1910, p. 248) the paper of Stargardt (*Archiv f. Ophthalm.*, Vol. 73, 1, 1910), refers to the fact that, until recently, references to the physiology of normal dark-adaptation were still based on the work of Aubert, who found that maximal retinal sensibility was attained after ten minutes' exclusion of light. Piper's more accurate researches have shown that hardly any alteration occurs during the first ten minutes, and that only after this does the rise in sensibility take place. This rise may be slow or quick in different individuals and after thirty or forty-five minutes the maximum adaptation is reacted, when the retinal sensibility may vary between 1,400 and 8,400 times its original value.

For an explanation of the anatomical and physiological changes which underly the process of adaptation we are, however, practically dependent on theory.

The author is an adherent of the Duplizitäts-Theorie, which ascribes separate and specific functions to the rods and cones. The former can only be stimulated by light through the agency of the visual

purple. They are color-blind and react to light stimuli which are so weak as to be below the threshold of the cones. These react directly to light, perceive color and are affected only by relatively strong stimuli. The cones take practically no part in adaptation, which, according to this view, depends on the visual purple, removed from the bleaching action of strong light, gradually accumulating and sensitizing the rods.

A wide range of ocular affections was investigated with the object of ascertaining the rapidity of adaptation and the retinal sensibility attained in different conditions after forty-five minutes light exclusion.

Piper's adaptometer was used, consisting of a box 75 cm. long, containing a fifty candle-power lamp at one end, in front of which, at distances of 25 cm., are placed three partitions of milk glass, each fitted with an adjustable diaphragm. The eye to be examined is first exposed to daylight for about half an hour and then the minimum illumination visible in the dark is obtained by the adaptometer. This gives the primary value and by reducing the illumination as adaptation progresses the maximum sensibility at any moment can be found. This is expressed as a multiple of the primary value and is obtained from scales attached to the diaphragms.

By means of a special perimeter and test-object having a variable illumination the field of vision was taken under similar conditions.

Among conditions of refraction, emmetropia and hypermetropia presented no peculiarities and the same held good for astigmatism, although in two cases of mixed astigmatism a considerable reduction of adaptation was found associated with poor vision after correction. In anisometropia the adaptation was sometimes equal, more often better in the eye with the smaller error, especially in cases of myopia. No connection could be traced between the differences in adaptation found in these cases and any ophthalmoscopic findings, or the age of the subject, or variations in local or general pigmentation.

A considerable part of the paper is devoted to myopia. Sixty-eight persons were examined and the results are given in several tables and plates of curves showing the relation of the adaptation to age, to the degree of myopia, and to the amount of visible change in the fundus oculi. Great reduction in adaptation was often present and on analyzing the cases this was found to correspond for the most part to the last mentioned factor. In about 50 per cent. of the cases examined a reduced field was found and in most, but not all, of these, ophthalmoscopic changes were detected.

Under affections of the retina and choroid the author mentions

opaque nerve fibres, Berlin's retinal opacity, retinitis albuminurica, siderosis and intraocular hemorrhage from various causes, in all of which reduction of adaptation was found.

Details are given of seven cases of retinitis pigmentosa, in nearly all of which the reduction in adaptation was extreme. By dark room perimetry it was found that this loss extended over a much larger area than that found to be scotomatous by the ordinary method. The author's view is that in this disease loss of adaptation precedes other visual disturbances. Unfortunately in the field reproduced it is not quite clear which area of shading is intended to represent the area of least retinal sensibility.

Fifteen cases of retinal detachment are fully discussed, especially in relation to the comparison of the field of vision as found by dark-room perimetry with that found by the usual method. This point is illustrated by comparative charts of several cases.

Stargardt considers that the field for white gives no accurate indication either of the presence of a detachment or of its extent, and that the color field is in most cases unreliable, the field for blue showing the extent of a detachment only in a few cases. On the other hand, as adaptation is totally absent in the detached area, the dark-field indicates correctly the presence and boundaries of a detachment. Adaptation, once lost from detachment, never returns unless reattachment occurs.

Varying results were obtained in twelve cases of choroiditis. Reduction of adaptation was not always found and no constant relationship between the ophthalmoscopic appearances and the amount of adaptation could be established. The dark-field, however, showed scotomata corresponding to the diseased areas.

Great reduction of adaptation was found in tabetic atrophy. Here a much greater restriction of the field for white and especially for colors was found than of the adaptation field. Neither the appearance of the optic disc nor the vision corresponded in any way to the amount of adaptation.

In retrobulbar neuritis central scotomata were sometimes demonstrated in cases in which the ordinary method failed to show them.

While admitting that many of these disturbances of adaptation have only a theoretic interest, Stargardt attaches practical importance to certain points brought out by his investigations. He believes that accurate information as to the boundaries of a retinal detachment or the extent of the lesion in retinitis pigmentosa is only to be obtained by taking the dark-field, because by this method functional disturbances may be detected which are not demonstrable by the older method.

This conclusion is based on a comparison of charts of fields of vision taken by both methods.

In the absence of detailed statements as to the size of the test-object and the radius of the perimeter used for examining the light-field—as opposed to the dark-field—the validity of such comparisons seems to the reviewer to be extremely doubtful.

The author does not appear to have used Bjerrum's method of mapping out the field of vision, which is capable of detecting amblyopic areas easily missed by perimetry at 300 mm. with a test object even as small as 0.5 to 1.0 mm. Dark-room perimetry has, however, the advantage of being more easily applicable to peripheral lesions.

Köllner (*Oph. Review,* Jan., 1911, p. 32) has noticed a high degree of interference with dark-adaptation (night-blindness) is an accompaniment of violet blindness in the cases in which that symptom arises from disease of the retina, but the two conditions are not exactly synonymous, as was shown by two cases most carefully analyzed by Piper and Köllner, cases of violet-blindness, probably congenital, in which adaptation was uninjured. On the other hand, violet-blindness is not a symptom of cases of acute night-blindness. It seems as though the two conditions of violet-blindness and night-blindness are closely allied phenomena which may exert their influence either on rods or on cones. Should the rods be affected, night-blindness would be the prominent symptom. As a general rule, however, both elements are necessarily affected, and since even under normal conditions alterations of function on the part of the cones are induced on reduction of illumination, it is easier to understand why the peculiar color deficiency is apt to accompany night-blindness or to be more marked in diminished light. See, also, Vol. I, p. 96, of this *Encyclopedia.*

Dark-cure. This is a combined treatment of ocular rest in a darkened room with previous application of the artificial leech behind the ear (over the mastoid process) or in the temporal region not far from the margin of the orbit. This is a popular form of therapy much employed in former times which has been recently revived by Eversbusch. He claims for it the best results in cases of intraocular congestion, especially of the choroid, in irritative or progressive myopia. Contrary indications are severe anemia, neurasthenia, diabetes, nephritis, advanced age and the menstrual period. Eversbusch recommends that the blood be drawn toward evening, 1 to 2 cylinders first from one side and on the next day the same amount from the other. After this the patient should remain in bed (and in the dark) for 24 to 36 hours. The room should, of course, be

well aired. The hyperemia following this form of wet cupping is best treated by ice compresses placed on the eye. See **Cupping.**

Dark lantern. A lantern with a slide or contrivance for concealing the light. A stereopticon.

Darkness-acuity. This term indicates the visual acuity when dark-adapted and then exposed to a subdued light. Under these conditions vision is, according to von Kries, entirely a function of the rods; consequently he has given to it the name "rod-vision."

In the macular region this phenomenon of darkness-acuity is lacking, but it rapidly increases laterally and, according to A. E. Fick, reaches its maximum about 8° from the fixation-point. At about 30° temporally from the fixation point it equals the ordinary acuity of vision, which in its turn rapidly falls off toward the periphery.

Darkschewitz's fibres. These cerebral radiations extend to the tractus peduncularis transversus from the ganglion habenulæ.

Darmblutungen. (G.) Hemorrhages from the bladder.

Dartre. (F.) Skin disease. Eruptions on the skin, such as herpes.

Dartre miliaire érysipélateuse. (F.) A rare form of skin disease, described by Poupart as relapsing annually, the eruption resembling herpes zoster and acute phlyctenular disease.

Dasyclonon. (L.) The *polypodium filix mas.*

Dasyma. (Obsolete.) Roughness on the internal surface of the eyelids.

Dasytes. (L.) Herpetic stiffness of the eyelids.

Date-palm. Phoenix dactilifera. In ancient Greco-Roman times, the kernels of dates were employed as a remedy for diseases of the cornea, for phlyctenulæ, and for madarosis. They were first reduced to ashes in an earthen jar, then mixed with nard.—(T. H. S.)

Datura arborea. Floripondio. A report upon this poisonous member of the Solanaceæ is given in the *Anales de Oftalmologia* (Sept., 1911) of the work in various sections of the Mexican National Medical Institute. The plant, native in South America, contains a small quantity of a substance which closely resembles atropin in its chemical properties, if it is not actually that alkaloid. Instillation of the impure active principle of datura arborea causes a dilatation of the pupil, which begins in fifteen or twenty minutes, reaches its maximum in twenty-four hours, and disappears after five days. Interference with accommodation, and increase of intraocular tension, also occur. Therapeutically, a double or triple dose of preparations of floripondio is required to produce effects equal to those of bella-

donna. The drug may be used for the same indications as are satisfied by hyoscyamus or belladonna.

Datura épineux. (F.) Datura stramonium.

Datura stramonium. THORN-APPLE. JIMSON WEED. JAMESTOWN-WEED. This is an annual species indigenous to Europe, but naturalized in America. It has widespread, forked branches and large ovate leaves, with irregularly-waved or toothed margins. The flowers are large, generally white, with a tubular, five-toothed calyx, the base of which, when the flower falls away, remains attached to the fruit, which is a fleshy, four-valved, four-celled capsule, covered with sharp spines. The leaves and seed (see **Stramonium-seed**) are official. The plant contains daturin (q. v.), atropine and hyoscyamine—and its physiological and toxic actions are practically identical with those of belladonna.

Daturin. The dried leaves of the Datura stramonium (Jimson weed, Thorn-apple, Jamestown weed) yield from 0.2 to 0.4 per cent. of daturin which is also found in various other species of the genus Datura.

This alkaloid is identical with hyoscyamine (or hyoscine) and duboisine and is isomeric with atropia. It occurs as colorless needles, soluble in alcohol and ether. The ordinary dose is 1/240 to 1/60 of a grain. It is a powerful poison, acting like belladonna. It is questionable whether it possesses any advantage over atropia which, in its pure state, it closely resembles both in its clinical and physiological aspects.

After scarifying the blood-vessels about the corneal margin in superficial ulcer Webster Fox (*Text-book,* p. 157) advises the use of the following formula: Daturin. sulph., gr. ss; acidi. boracici, gr. vj.; acidi carbolic., m. j; aquæ dest., fl. ʒj.

Five drops to be instilled four times daily.

Daturism. A morbid mental and bodily condition induced by poisoning or excessive dosing with stramonium (*Datura*). It is nearly or quite identical with atropism. See **Toxic amblyopia.**

Daughter-cyst. A cyst formed within a cyst.

Daughter-nuclei. A term used in karyokinesis, which means the entire series of changes taking place in a nucleus during indirect cell-division or nuclear-division. In other words, the structural changes occurring in the nucleus during indirect division are complicated and seem to differ somewhat in different cells; so also the number of distinct phases assumed by the nucleus in passing from mother to daughter nuclei, and the nomenclature of the phases, are still subjects of discussion. So far as can be seen, (*a*) the nuclear membrane

and the nucleoli disappear, with thickening and dense convolution of the nuclear fibrils and an enlargement of the entire nucleus; (*b*) the nuclear fibrils become looped and arranged like a rosette or wreath; (*c*) the peripheral parts of the loops disappear, there results a star-shaped figure (*aster*) of V-shaped segments of the nuclear fibrils, and the fibrils forming these segments then divide longitudinally, forming double V's; (*d*) the fibrils become depressed so as to give a disc-like or plate-like figure (nuclear plate), and this plate divides longitudinally, the two halves recede from each other, and each assumes a stellate phase (disaster stage or phase); (*e*) the fibrils of the disaster become arranged in a wreath and then into a convolution, and finally become surrounded by a membrane (nuclear membrane), and nucleoli appear. They are then called daughter nuclei, and are similar to the original mother but smaller. The body of the cell may divide by simple segmentation or fission at any time after the disaster phase, or the cell-body may remain undivided, in which case there results a bi-nucleated or multi-nucleated cell.—(Foster.)

Davidsohn's sign. The pupil reflex induced by light reflected through the pupil in transillumination, when the electric light is held in the mouth.

Daviel, Jacques. Inventor of the extraction of cataract, and, therefore, one of the greatest ophthalmologists of ancient or modern times. He was born, as the son of a village notary, at Barre, near Rouen, Normandy, Aug. 11, 1696, and died Sept. 30, 1762, at the Hotel Balance in Geneva, Switzerland. Concerning his early education we know absolutely nothing. We do, however, know that he studied surgery both at Rouen and at Paris. In 1713 he was assistant surgeon in the army, and served in numerous hospitals.

About this time the pest was brought to Marseilles by a ship returning from the Orient. The disease spread rapidly over the whole of Provence, and raged with frightful mortality. In Marseilles, of 100,000 inhabitants, over 50,000 perished. The physicians of the afflicted district called for volunteers. One of the first (and bravest) to reply was Daviel. This was in 1719. He had just married, and, accompanied by his young bride, he went to the afflicted district, where, day and night, he assisted the suffering and was utterly unmerciful to himself. He worked at Toulon, Arles, Salon, and Marseilles. As a result of these untiring services, he received from the King a decoration which bore these words: "*Pro Peste fugata.*" He was also appointed Surgeon-Major to a galley.

In 1728 he began to devote himself exclusively to diseases of the eye, and soon had a great reputation. In 1736 he was called (in his

capacity of ophthalmic surgeon) to Lisbon; in 1745 to Madrid; and, in 1750, to the Court of the Elector at Mannheim. Not, however, as an operator, however useful, will Daviel be remembered so long as ophthalmology shall endure, but as the inventor of the extraction

Jacques Daviel, Inventor of the Extraction of Cataract.

operation for cataract. The story of this marvelous matter I therefore give almost in full below, in a fairly literal English rendering of (1) the first, and (2) the most important communication made by Daviel himself upon the subject.

Of interest to ophthalmologists Daviel published, all told, the following writings:

1. Lettre sur les Maladies des Yeux. (*Mercure de France*, Paris, 1748, pp. 198-221.)

2. Sur une Nouvelle Methode de Guérir la Cataracte par l'Extraction du Crystallin. (*Mémoires de l'Académie Royale de Chirurgie*, T. II, Paris, 1753, pp. 337-352.)

3. Deux Lettres sur les Avantages de l'Opération de la Cataracte

par Extraction. (*"Journal de Médecine,"* Paris, Fevr., 1756, pp. 124-128.)

4. Reponse de M. Daviel, etc. (*Mercure de France,* Janvier, 1760, T. II, pp. 172-196.)

A complete treatise on ophthalmology was promised by Daviel in the 2d item of the foregoing list. According to Moran, such a treatise was left by Daviel in MS. but it has never been published or even found.

The *"Lettre sur les Maladies des Yeux,"* above-mentioned, was addressed to Dr. Joyeuse, at Marseilles, and published, as above-indicated, in the *Mercure de France* for Sept., 1748. The parts of greatest interest run as follows:

"You are right to complain of my silence. Today, however, I report to you concerning a few ophthalmic operations which I have performed since Nov. 7, 1746, the day of my arrival at Paris.

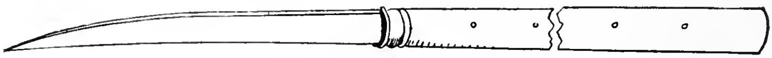
"A cataract operation had always appeared to me a proceeding of doubtful character, though the public had imagined that it never could possibly miscarry except as the result of the operator's unskillfulness. Only after many experiments on cadavers and numerous operations on the living, in order to improve the depression operation, did I come to recognize all the dangers and doubtful points. It almost seems as if I do injustice to that art to which I have devoted myself for eighteen years. However, let the cataract be as favorable as it may, the health of the patient as sound, and the operator's skill as perfect—now and then there follow symptoms which the most experienced ophthalmologist is not able to explain: re-arising of the cataract, epiphora, vomiting, swelling of the conjunctiva and of the eye with outrageous headache, yes, even complete suppuration of the eye. These mishaps I have witnessed subsequent to my own operations and also to those of the most distinguished ophthalmologists.

"I have already communicated to you in Marseilles what happened to me on April 8, 1745, in the case of a cataract operation on Bro. Felix, Hermit of Aiguille, in Provence. For a full half hour I worked in vain. At the second operation on the same eye I employed the new needle, invented by me, which has neither point nor edge. The patient distinguished all objects. However, inasmuch as the eye had been weakened by the first operation, the second was followed by suppuration—a fact which I attribute to the shortness of the interval allowed to elapse between the operations.

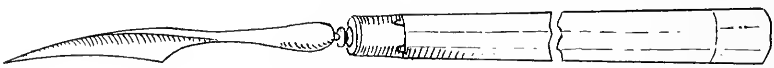
"Nevertheless, I made new experiments on cadavers, and then performed, one after another, seven depressions with complete success. The seventh case was one that came from Paris, and the opera-

tion in that case brought me glory. I was called at once to Paris, in consultation with M. Morand. In Paris I was visited by 400 eye-patients and I performed 200 ophthalmic operations, both for cataract and also for other disorders. Of cataract operations I performed 75, of which a few were complicated with great hindrances; but 61 were successful: more could not be properly expected from a new method.

.Thos. Young's Cataract Knife.

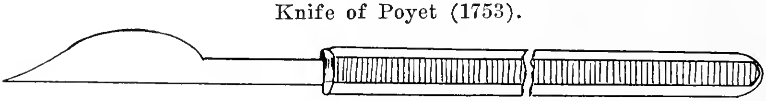


Knife of De La Fay (1753).



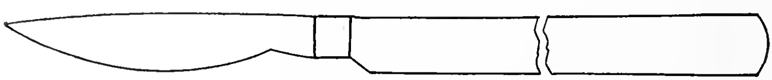
Knife of Sharp (1753).

Knife of Poyet (1753).



Knife of Beranger (1756).

Knife of Tenon (1757).



Knife of Pamard (1759).
First Knives Used in Cataract Extraction. (Hubbell.)

"I am now almost convinced that nothing can be more dangerous than to introduce a sharp and incisive needle into the ocular interior: wounding of the posterior iris-surface, of the ciliary-body, and of the pupil [*sic*], with resultant hemorrhages, are not to be excluded from among the results of a depression so performed.

"None of these things have occurred any more to me, since I began to open the ocular tunics with a small lance, and then to introduce my new needle, which possesses neither point nor edge. This I can turn at will inside the eye, without the slightest fear of producing injury. The results are far better than by the earlier pro-

cedure with the sharp needle, which, in ten cases, has given but 5 to 6 successes. But I do not claim the new procedure to be infallible.

"Moreover, I have executed an extraction of cataract which still lay in the posterior chamber, from the right eye of M. Garion, a master-wigmaker. The observations which I made at this successful operation have aroused in me great ideas concerning the extraction of cataract.

"After I had done my best to depress this cataract, but without success, I decided to open the lower portion of the cornea, in order to get my needle the more certainly into the posterior chamber. Then, for a long time, I held the cornea up by a small forceps, and brought forth the lens, thanks to the opening which I had just made, although the aqueous humor had completely escaped and even a tiny portion of the vitreous: occurrences which, however, did not hinder the patient from recognizing every object that was shown to him.

"I beg of you to give to this operation the attention it deserves, since the heart of the matter is this—a cataract which was extracted from the posterior chamber, not the anterior.*

"This operation of mine is by so much the more remarkable (besides the fact that, in my opinion, it stands without example) as it offered immense difficulties, for I had to open a cornea that was absolutely flaccid.

"The operation was so successful that the patient, afterwards, did not feel the slightest pain. With a cataract glass he read accurately. The eye resumed its natural appearance, aside from a slight lengthening of the pupillary border, a matter which no one but a specialist would notice."

This is very interesting indeed. Much more interesting still, however, is the following *"Sur une Nouvelle Méthode de Guérir la Cataracte par l'Extraction du Crystallin,"* published five years later, and perhaps the most important contribution ever made to ophthalmologic literature.

"A person will cease to wonder that ophthalmic diseases, and especially cataract, are studied so little and treated with such inconspicuous success, when one merely bears in mind that, by a peculiar fate, ophthalmic surgery is, at least in a manner of speaking, handed over as a prize to the quacks. Skillful men of the last century have freed us from the error concerning the nature of cataract in which the ancients were entangled. The ancients believed that a cataract consists in a kind of membrane, and that this membrane is formed

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* See, herein, St. Ives.

by an inspissation of the aqueous humor. But now we know that a cataract consists in a clouding of the crystalline lens. That is a truth which everybody knows and nobody contests. Therefore I will waste no time in adducing new proofs. We are chiefly indebted for the discovery in question to the famous Lasnier, fellow of the College of Surgeons at Paris, who had knowledge of the matter very long before Maître-Jan and Brisseau; but the true proposition was essentially confirmed by these two later men.

"A number of savants have written about this disease, but only a very few have done the operation which the disease requires, and only an inconsiderable number of the great surgeons have occupied themselves with the matter to any great extent.

"Did I employ the customary speech of ophthalmologists, I should discriminate a number of kinds of cataract; but, as the numerous divisions of the disease appear to me to be unnecessary, I will admit but two varieties: the true cataract, which is a good kind, and the false, which is a bad kind.

"The true cataract is a clouding of the lens, either of the whole or of a part; without the accompaniment of any other ocular affection.

"It is not the color which declares the favorable variety; but the eye must be otherwise sound, the pupil must dilate (by 1/2, 1/3, 1/4) and the patient must be able to distinguish light from darkness.

"The false cataract, that of the bad variety, consists of a clouding of the crystal, combined with immobility of the pupil, which is either too markedly dilated or contracted. The patient cannot descry the shadow of an object. These signs sufficiently often indicate amaurosis. Then there may be also severe headaches, a stubborn ocular inflammation, and the like.

"The ancients, who regarded a cataract always as a membrane, invented ways and means of depressing it in correspondence with that view. Some made use of round needles, with a view to rolling up the membrane like a ribbon; others, of needles that were sharply pointed, the less to injure the sclera; a few employed cutting needles in order to sever the thread, which, according to their view, affixed the cataract to the ciliary processes; at length Freytag invented a spring-pincette, ending in needles with which he designed to draw the membranous cataract out of the eye.

"In 1745, at Marseilles, in the conviction that sharp and incisive needles produce those accidents which often enough are seen subsequent to the ordinary operation, I invented a flat and blunt needle with a spatula-shaped extremity, with which I believed that I could

depress a cataract more successfully after I had made the puncture with an ordinary needle. But experience has convinced me of the contrary, and the operation which I am soon to describe has not a little contributed to awaken in me the considerations to which I owe the procedure which I now am practicing.

"A hermit of Aiguilles, in Provence, who had already undergone an unsuccessful operation on his right eye, came to me at Marseilles, requesting that I try the second eye. I was, unhappily, no more fortunate than was my predecessor. By means of the ordinary needle, cutting on the side, I was in no position to depress the cataract. Indeed it came to this, that several fragments of the broken up cataract arrived in the anterior chamber. I saw this chamber filling up with blood until my needle was no longer visible, and I had to withdraw my instrument from the eye before completing the operation. This accident decided me, after the example of M. Petit, to open the transparent cornea for the purpose of removing the blood and the fragments of the cataract from the anterior chamber. I introduced a half-curved needle, and enlarged the first opening in the cornea with small curved scissors: thereupon came out all that had been in the anterior chamber, the pupil became clear, the patient distinguished at once all objects held before him. But, as his eye had been too greatly weakened by the first operation, the second unfortunately remained without success and was followed in two days by suppuration of the organ. These accidents were, without doubt, occasioned by the traction on the internal membranes and by the dilaceration of the vitreous body.

"This case, which accident had brought before me, occasioned me to decide that, thereafter, I would only operate in that very way in which I had carried out the procedure for the hermit, through an opening of the cornea to go in quest of the lens in its capsule, to bring it through the pupil into the anterior chamber and to extract it from the eye. I did this operation for the first time for a woman. I opened the cornea in the way mentioned, brought the little spatula, which I have already described, upon the upper portion of the cataract, made it free and drew it piecemeal from the eye by the aid of this instrument. The pupil was clear, the patient had not the slightest accident, and, fourteen days later, was completely cured.

"Encouraged by this success, I carried out this procedure on four other patients in order at least to institute a comparison of these difficult methods and to try whether I might find one which should be free from the all-too-frequent accidents.

"I determined to perform the cataract depression with two instru-

ments. The one, of steel, was a small, straight knife, for the purpose of opening the scleral membrane at the customary place. Through this opening I at once passed the little spatula against the highest portion of the cataract, between the latter and the posterior surface of the iris, and thus completed the depression of the cataract with ease and safety.

"After a large number of operations, performed in accordance with this method, some in the presence of the most distinguished masters of the art, had produced remarkable results; I believed I might dare to conclude that this method was preferable to the other.

"I was in a position personally to compare all that had been until that time invented, especially instruments and methods.

"All sorts of needles have been employed by me. I have also performed the operation in various manners, inasmuch as I now brought the needle behind the crystalline, in order to break through the posterior lamella of the capsule, and now sought to open the capsule at its under part in order to cast the lens into the vitreous *via* this opening. But I have observed that the operation, when performed by the last-named method, only succeeds exactly when the lens-capsule is very thin and delicate. Then the lens, when it has been cast beneath the vitreous, does not rise again so easily, and there follow only a few accidents which are common to all sorts of operations. However, it is very different when one strikes a firm capsule, a soft cataract and a rather thick vitreous: then the irritation of the membranes by the needle and the necessary splitting of the vitreous, sometimes occasion very considerable complications, now and then even suppuration of the eyeball and wasting of this organ. Although I had used, as one might say, every sort and kind of cataract operation, still I was not satisfied with the results, and instituted new investigations, in order to determine with exactness what disturbance of the inner portions of the eye must of necessity follow the operation with a proper needle. The results of the operation were very various. Truly, in a few happy experiments, the pupil was found clear and the lens at the bottom of the vitreous, without any sort or kind of disturbance of the inner parts. But, in other cases, the pieces of the lens which had been broken up by the needle, arrived in the anterior chamber; the more I moved, or stirred, the needle in the eye in these cases, the less did the eye become clear. Sometimes I found the greatest difficulty in removing the lens from its capsule, and finally it happened to me to find it between the retina and the choroid, and both of these membranes torn in different places.

"I doubted then no longer that the disturbance of the different parts, which I had witnessed in cadaver's eyes, and which exhibited a very great variety, was the cause of those disorders whose unhappy effects made themselves only too perceptible in the living. I must therefore believe that those disorders depend not only on the introduction of the needle into the eye, of whatsoever kind that instrument may be, but also on the resistance of the membranes, and, before all, of the lens, according to the place in which it came perchance to lie after the depression.

"Indeed, if one only considers a little the form of the different needles, one immediately perceives that those which are thin and pointed only stick, or pierce, and, as they do not present a sufficient surface, often enough they cannot press upon the cataract sufficiently to depress it into the depth of the vitreous, or, at the least, that they must occasion those accidents which accompany the wound of puncture.

"The cutting needles sever the blood vessels, and often occasion hemorrhages into the ocular interior, which hinder the completion of the operation.

"Those which are flat, blunt, and rounded off, may contuse and lacerate the inner membranes of the eye, and, by consequence, occasion disagreeable accidents.

"Aside from the accidents which must be attributed to the needles, the lens itself may, of course, by its mere presence, injure the different portions of the eye—a fact which, as above remarked, depends upon the different situations which it may assume subsequent to the depression. I pass over the accidents which the most careful operator cannot entirely avoid, though he be as careful as he may.

"Spite of these various unfortunate matters, I believed that I might employ my last procedure, by preference, still more widely—a procedure which consists in this: first, to employ a cutting instrument, and afterwards a flattened needle, for the purpose of depressing the cataract, until the idea which I had won from the operation on the hermit had attained in my mind to a certain ripeness. But the occurrence of which I am about to speak, gave to my conviction its final completion.

"On the 8th of April, 1747, I was called to a private person" (no doubt the master wigmaker, M. Garion, referred to in the earlier publication) "whose cataract appeared to be very favorable and the eye, also, in good condition for an operation. I began to operate on the left eye, whose cataract appeared to me to be the more solid. However, it was not possible for me to depress it. The pupil re-

mained clouded after the operation, and the patient saw absolutely nothing. I then passed over to the right eye, with which I also had much trouble. Inasmuch as I could by no means depress the cataract in this eye, I decided then to open the cornea, as I had done in the case of the hermit. I enlarged the opening, then with a small pincette held the cornea well up and passed through the pupil my small spatula, with which I extracted from the posterior chamber the entire lens, which had divided and then been broken into pieces by the first operation which I had made already on this eye. The extraction was followed by the exit of a part of the vitreous, which, in fact, had also been divided by the earlier operation. But in spite of this disturbance, the patient distinguished objects very well after the operation. The latter had no bad results. The patient was well a very short time afterward.

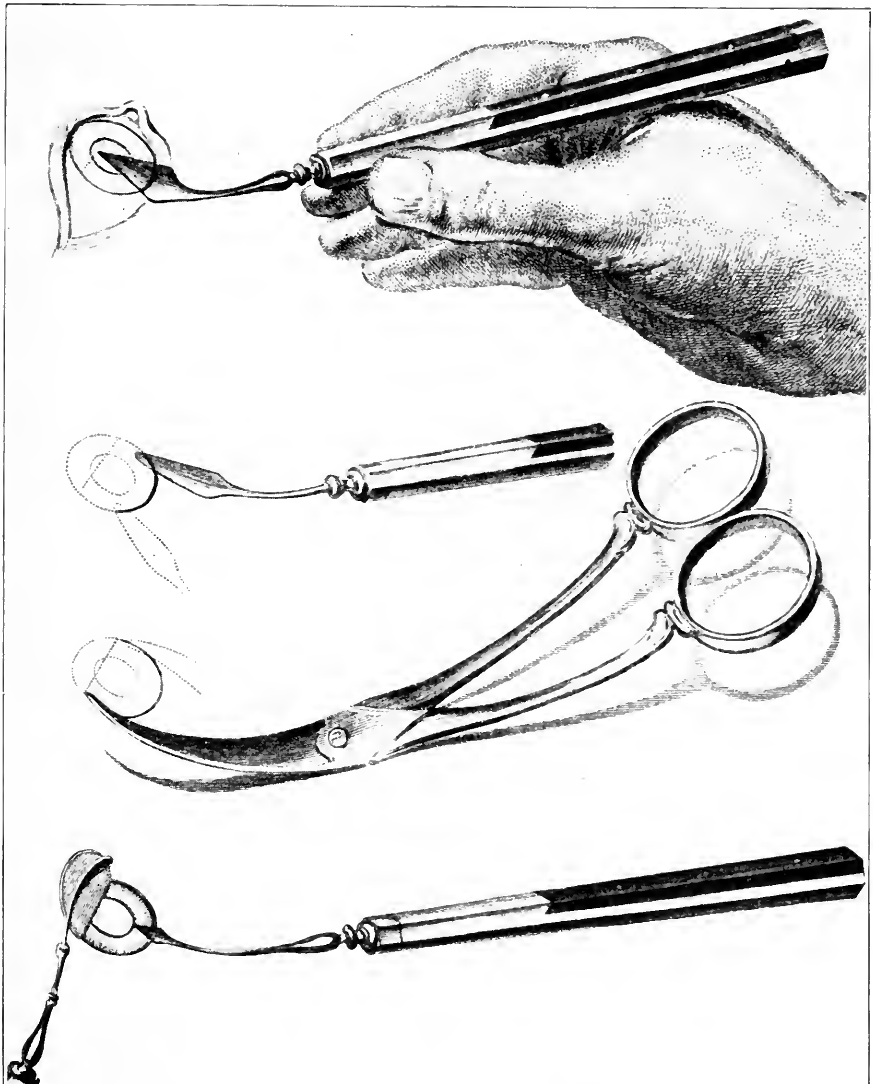
"After this time and during the three following years I performed this operation several times upon the living, in order to get accustomed to it gradually. But, for the first time, while on a journey to Mannheim for the purpose of treating the Electoress of Zweibrücken for an old affection of her left eye, I came to a firm decision in the future to operate for cataract only by extraction of the lens.

"I had occasion to pass through Lüttich and to stay there for a time. There I performed six operations in accordance with this method and all with the greatest success. One which I performed at Cologne on a priest of a religious order, yielded a very surprising result, inasmuch as the cataract was as soft as jelly. In spite of that fact, the priest was able, fourteen days later, to read the mass.

"Herr von Vermale, corresponding member of the Academy and surgeon-in-chief to the Elector of the Palatinate, has reported the operations which he saw me perform at Mannheim in a letter which he caused to be printed, and which he addressed to M. Chicoyneau, first physician to the King. Since that time I have used this operation further in different places, and reckon up to this time (Nov. 15, 1752) 206 operations, of which 182 were successful. That means, I think, that one can infer a decided advantage from an operation which has only just now been invented. Hereunder I give a description of the details.

"When a diagnosis has been made of cataract, then questions do not arise, for this method, as to the condition of the cataract, its age, softness, hardness, or color. The operation will be equally successful, provided the eye is otherwise sound. For the chief purpose of my operation is the extraction of the cataractous lens from its bed.

That is very easily attained under the precautions of which I shall shortly speak.



Daviel's Cataract Instruments and His Method of Procedure.

"The preparation of the patient I carry out in the usual well known manner. On the day selected for the operation, I place the appurtenances in order; these consist of bandages, compresses, tiny bits

of linen, lead plaster cut egg-shaped, pledgets of cotton, warm water and wine.

"The instruments which I employ are (see figures): 1. A needle, sharpened to a point in front, cutting on the side, somewhat curved, and lance-shaped, for the first opening (fig. 1). 2. A needle blunted off in front, cutting on the side, also curved, for the purpose of enlarging the first opening (fig. 2). 3. Two curved, convex scissors (fig. 3). 4. A small spatula, of gold, silver, or steel, slightly curved, for the purpose of lifting the cornea (fig. 4 A). 5. Another small needle, sharp forward and cutting on both sides, for the purpose of opening the anterior capsule of the lens. 6. A small spoon of gold, silver, or steel, in order to facilitate now and then the exit of the lens or to extract pieces of its substance when these remain behind in the pupil. 7. A small pincette, for the purpose of removing bits of membrane, which may perchance be present.

"All these instruments are arranged in order upon a plate, and entrusted to an assistant whose business it is to reach them to the surgeon as needed.

"When all is thus arranged, the patient is brought into a room of only moderate brightness, in order that a too strong light may not contract the pupil and enter the eye too abundantly subsequent to operation, which may produce dazzling.

"The patient is set on a rather low stool, or on a chair without any back. The operator sits upon a higher chair, in front of the patient and facing him, so that the former, while he operates, can support his elbows with his knees.

"He covers the other eye with a bandage. Then an assistant, standing behind the patient, lays one hand upon his forehead, lifting the upper lid with two fingers, while the second hand is laid beneath the patient's chin.

"The surgeon draws down the lower lid, A, see figures, seizes the first needle, sinks it into the anterior chamber, close to the sclera, while he avoids all injury to the iris, and passes it higher than the pupil, then he draws the needle very gently out again, takes up the blunt-pointed needle, and enlarges therewith the incision already begun, drawing the instrument to right and left, in order to open the cornea in the form of a half-moon, corresponding to its curvature (CC).

"But, as the cornea is then a little flaccid, the surgeon takes up the curved, convex scissors (D), brings its blunt arm between cornea and iris, and completes the incision first upon the one, then on the

other, side (EE), in order to bring it on each side a little above the pupil.

"One should, of course, observe that the convexity of the scissors must be directed toward the eye. With respect to the curvature-on-the-flat, therefore, two pairs of scissors are essential, which fit the curvature of the cornea as well on the nasal as on the temporal side.

"The surgeon takes then the small spatula (F), raises with it gently the separated portion of the cornea (G), and incises with the little edged and pointed needle (H) the capsule of the lens. Sometimes one has to cut this membrane all around and remove it in its entirety, when it is thickened and folded; and then it can be drawn out, when well cut round, with the tiny forceps.

"When one has circumcised the membrane which enclosed the lens, then he must carefully introduce the small spatula between the body of the lens and the iris, in order to make the cataract entirely free and to facilitate its exit. Now the surgeon needs all his foresight. He is about to remove the veil that covers the light. To this end he presses very gently on the ball, avoiding even the slightest pain. (Note the fingers so employed, JJ.) Thus the operator avoids rupturing the posterior capsule of the lens, which acts like a dam to prevent the exit of the vitreous humor. With delight is seen the gradual dilation of the pupil, and the soft gliding hither of the lens (which first allows its margin to appear) in the anterior chamber and from there upon the cheek. At once the pupil is clear; the cloud which covered the eye has been dissipated; the patient, who before was plunged in darkness, glimpses the day with astonishment and satisfaction.

"Now one sets in order the pupil, which sometimes, through the exit of the cataract, especially when it is hard and firm and very large, loses its regular shape. When the operation is complete, the patient is bandaged, in order to guard against the effects of excessive light.

"Should it happen that the cataract is soft and tough, so that it breaks in pieces, then the fragments can be removed by means of the tiny spoon, which the surgeon passes into the pupil as often as necessary. Then the corneal cap is accurately replaced, the eye is wiped gently with a soft and delicate sponge, dipped in lukewarm water (in which have been mingled a few drops of alcohol) or else in some sort of collyrium. The plaster is laid on the eye, on that a little cotton in pledgets, and the whole is fastened with a bandage, but without any pressure. One covers the head with a linen cloth,

has the patient lie down in a dark room, if possible on the back, and in a bed surrounded by curtains.

"The eye is bathed in a softening and solvent decoction, twice or thrice a day, and as often as seems to be necessary. One should not forget blood-letting and a correct mode of life. The patient is, besides, treated on general principles.

"Howsoever strongly convinced I may be of the advantages of this operative procedure, yet I cannot deny that it is also liable to its own peculiar accidents. Yet these are of such a kind that one can easily remedy them, indeed a few can be prevented. During the performance of the operation, for example, a part of the vitreous can come out from the eye; but this can be avoided well-nigh to a certainty, by only pressing gently on the eyeball, when causing the lens to come forth.

"There are indeed cases in which it seems to be necessary to employ a heavier pressure. If the capsule of the lens is adherent to the iris, the union must be separated with the small spatula; then the pupil slowly yields for the exit of the lens.

"If, because of injury to the iris, blood is once effused into the anterior chamber, it will quickly run out of itself through the corneal incision; it in no wise hinders the operation. This accident recently occurred to me in the presence of Mm. Dran, Morand, la Faye, and a few others; the eye received no harm from it, the patient sees just as well with it as with the other, which was operated upon immediately after its fellow.

"That all the aqueous humor is lost at once, is a necessary, but harmless, unpleasantness. If, however, one withdraws too rapidly the needle used for opening the cornea, the iris may follow the aqueous: it is then caught betwixt the lips of the little wound. However, it is easily freed by lifting the cornea very gently with the tiny scalpel. Sometimes merely the natural movements of the eye result in the reposition of the iris.

"In the course of the treatment the iris may again prolapse, and form a staphyloma. But this is easily remedied by shoving the iris back. Prolapse can also almost certainly be prevented by taking care when binding up the eye not to do the bandaging too tightly, for the accident in question is almost always caused by too great pressure.

"I believe it will be admitted without further remark that these accidents signify little in comparison with those which may occur after the customary methods. But these are not the only advantages

of my procedure. A comparison with other methods brings out plainly much more considerable points of superiority.

"1. If a person operates according to the old procedure, he has to wait till the cataract is ripe.

"2. When a cataract is depressed, it may, no matter how fast it is, once more arise. One cannot deny that this accident now and then occurs. Here, on the contrary, one is perfectly certain that a cataract extracted from the eye will never rise again.

"3. After the usual procedure, the cataract sometimes arrives, either wholly or in part, in the anterior chamber; that occurs sometimes in the course of the operation, and, further, as is well known, several years thereafter. As the cornea is not opened, the cataract plays the *rôle* of a foreign body in the anterior chamber, and its movements may be very disagreeable; indeed it may even occasion the loss of the eye, or, at all events, render necessary a second operation. By my method I remove the cataract absolutely and completely from the eye, after bringing it (advantageously) through the aperture of the pupil.

"4. If a person operates in the customary manner on a soft cataract, the operation often remains uncompleted because of the bits of torn-up capsule, laden with tough fragments of lens, which may close the pupil, and, thereby, offer to the rays of light the same obstruction as an entire cataract. By my procedure I have extracted also soft cataracts; I have removed a few that resembled bladders filled with water; I have loosened some that had become adherent.

"5. In order to depress the cataract according to the old procedure, one must press through the vitreous body and cut into its branches, which sometimes, by the more or less frequent motions of the needle, are wholly torn up. That cannot occur without decided consequences, and cannot be wholly avoided by the use of needles devoid of point and edge. It is easy to perceive that this accident cannot occur by my procedure.

"I believe that I have now said enough to prove the superiority of this procedure, and the preference it deserves over the others. It has won the suffrages of those masters of our art before whom I have been able to operate; a number have already adopted it. It remains only for me to prove further that I am the inventor of this operation, whose discovery by me has been disputed—I know not from what motives.

"The ancients all asserted that a cataract is a membrane which forms in the anterior chamber from the aqueous humor. Only since 1656, as I remarked near the beginning of this article, has it been

recognized that a cataract consists in a clouding of the lens. It would therefore be in vain to seek among those authors for the procedure of extracting a cataractous lens.

"The objection may perchance be made that the ancients, in their acceptance of a membranous lens, had invented the extraction of the membrane, and that this is proved by the works of several Arabic authors, as Avicenna and Rhazes.

"It is easy to answer this objection.

"1. Let us grant that this operation was actually executed. It had for its object merely a membrane. This in no wise lessens the merit of the extraction of the lens, which comprises a wholly different idea.

"2. If we accept the sentence of Avicenna which M. Thurant, Baccalaureate in Medicine of the Faculty at Paris, adduces in the thesis defended by him in 1752 on the extraction of cataract; even then no objection can be raised which robs me of the credit of the invention. The text of Avicenna runs as follows: 'Et homines vias habent diversas in exercendo curam aquæ, quæ fit cum instrumento, ita ut quidam sint, qui disrumpant inferiorem partem corneæ, et extrahant aquam per eam; et hoc est in quo est timor, quoniam cum aqua, quando est grossa, egreditur humor albugineus.' M. Thurant remarks upon this: 'Aqua apud Avicennam idem est ac suffusio, hypochyma. Grossam dicit cataractam duriorem.' If one examines this text, he finds not the description of a cataract as we understand it; and, if I even admitted that Avicenna was speaking of the cataractus lens and its extraction, has he then left to us in express language the manner of executing this operation? Ought I not to have the honor of reviving the operation and of publishing the means whereby it may be performed?

"One needs further to consider only the testimony of those authors who have spoken of the extraction of cataract. I know only two, Mm. Freytag and Heister. The first considered only membranous cataracts, and was adequately refuted by Heister, who doubted his operation.

"The second, Heister, says in his Surgery, part 2, Sec. 2, chap. 55, p. 578, that he had heard that the English ophthalmologist Taylor had boasted, *gloriatum esse,* that he had been able to extract a cataract which *stuck* behind the uvea, by means of an incision in the cornea. But, as Heister adds nothing further, he communicates to the public only a rumor and a possibility. It is true that M. Thurant makes an addition to these words of Heister, to the effect that Taylor had actually performed this operation several times

in the year 1737. But I fear that this is a groundless assertion, and believe that I can so prove.

"When Mr. Taylor, in 1750, was in Austria, he operated in the presence of the famous van Swieten, fellow of this academy. One would not impute to Mr. Taylor such neglect as to remain silent about the extraordinary operations which he had performed; he would certainly have given to Herr van Swieten all the information concerning them. Nevertheless, the latter, in a letter of April, 1751 (an answer to which Herr von Vermale, together with a copy of his article—on my cataract operation—had sent to him) does not mention Taylor's name so much as once, on the contrary admitted that by following my procedure one could avoid numerous accidents, and finally adds the following: 'The only difficulty consists in this: to cause the lens to come forth, especially when it possesses a considerable circumference. For it appears to me that, in that case one must do considerable violence to the iris. There are people in whom this opening is very narrow and little to be enlarged. However, the frequency of the happy result of an operation counterbalances all the difficulties which can be alleged against it; and a skilful hand arrives at a successful issue with many things which to others appear very difficult.' Had Hr. van Swieten seen Mr. Taylor, or any other, perform this operation, he would not have given so clear and definite an answer. This great physician is not the only one who has assigned to me the credit of inventing this operation. I add the favorable report of Hr. Welken, physician to his Highness the Elector of the Palatinate and the witness of M. Mauchart, professor of therapeutics in Tübingen, first physician to the Duke of Würtemberg and without doubt the most famous ophthalmologists in all Germany.

"I expect from the public itself that justice for which I have reason to hope; and I believed that, in order to assure myself thereof, I could do no better than to set forth my discoveries in the annals of the Academy.

"I close with the remark that this article is merely an abstract; I hope to publish the entirety in a complete treatise concerning the diseases of the eye."

Daviel at once became famous. Doctor and layman alike were pleased to sound loud pæans to the conqueror of grim darkness. The painter, François de Voge, whom Daviel had cured of an adherent cataract (using, it is well to remember, for his other eye was absolutely blind, the very sight that Daviel had given him) designed an allegorical picture, "representing the famous surgeon marching to

Daviel Marching to Immortality. (De Voge.)

immortality." This picture I herewith reproduce, together with an English rendering of the explanation, or interpretation, of the picture, given (at second hand) by Jules Hédou in his work, "Noël Le Mire et son Oeuvre" (Paris, Baur, 1875, p. 59): "No. 25—Daviel, SURGEON-OCULIST, according to de Voge. Allegorical print representing this famous surgeon marching to immortality." It is described in the explanation which is sold with the plate and which is thus expressed: "Explanation of the plate attached, engraved by the Sieur Noël Lemire,[1] according to the design of the Sieur François Devoge,[2] painter, dedicated by him to M. Daviel, surgeon to the king, *par quartier,* and oculist to his Majesty, the first Tuesday in January, 1760."

"The Sieur Devoge, painter, of Grai in Franche-Comté, resident now at Paris, in the Rue Mêlée, being yet blind at the age of 20 years, because of having two cataracts of the worst kind (for they were adherent) was operated on in the left eye without success by a very able surgeon in 1753. In 1756 he went to Paris in order to find M. Daviel, who operated on his right eye on Monday, the 24th of May, in the same year. Although this cataract was even worse than the other (since not merely adherent, but also osseous) the operation was nevertheless followed by the most happy success. The details may be found in the Observations of the Royal Academy of Sciences at Stockholm, for the months of January, February and March, 1759, page 43, communicated to this academy by M. Daviel, Sept. 10, 1758. Sieur Devoge, filled with gratitude for his benefactor, has just dedicated to him an allegoric design which shows how deeply indebted he is to the extraction of cataract, of which M. Daviel is the inventor.

"This design is an allegory, composed of eight figures in three groups, of which the principal represents Invention, which forms the subject of the design. This personage appears under the form of a young girl, seated on a cloud, holding in her left hand a caduceus, the symbol of science, and a hand, in the midst of which is discovered an open eye.

"Invention, with her right hand, points out the distant Temple of Memory to the tall, straight figure, which appears at the bottom of the cloud: this figure represents the author of the extraction of cataract, who, with his right hand, holds a genius by the left. This genius is that of the author, characterized by a flame of fire

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1 The name is spelled Lemire and Le Mire indifferently.
2 The name is spelled de Voge, De Voge, and Devoge indifferently.

on the middle of the forehead, sign of a lively imagination: the same genius holds in his right hand the two principal instruments used in the extraction of the crystalline lens from the eye—a needle in the form of a lance and a pair of curved, convex scissors.

"On the left of Invention, one sees another figure, seated on the same cloud, but a little lower. This figure represents Experience, under the form of an old woman, who supports herself upon an open compass, in the middle of which one notices a plummet, in order to show that a true and sound Experience should be solidly supported on certain and evident rules. Behind Invention and Experience one sees Fame, holding a lighted torch in the right hand, and, in the left, a trumpet. The torch is a symbol of Fame of a spotless character, publishing to all the world the happy results of the extraction of the crystalline lens.

"Above Fame, and wholly in the corner at the left, one sees a beaming sun, covered a little in front by thick clouds, which the rays of the sun chase to right and left. These clouds form an allusion to cataract, which obfuscates the eye before operation. At the very bottom, in the left hand corner, one perceives two little geniuses, supporting a medallion, in which is represented M. Daviel. The upright genius represents Sieur Devoge, author of the design, characterized as the Genius of Health, who shows to the seated genius that it is the portrait of the author, who has returned to him his sight. Health is figured by a cock perched upon a caduceus. Below the right hand genius, is observed a group of instruments employed in the diseases of the eye; and, below the Temple of Memory, several steep rocks indicating the inaccessibility of this temple, whither it is very difficult to arrive without long labors, well considered studies, and without a sequel of perfected experiences frequently repeated and thoroughly confirmed."

Of the literary tributes to the great oculist, the following poem, by "Mr. L. Chr. D. F.," which appeared in the *Mercure de France,* July, 1752, at p. 55, may be taken for one of the best:[1]

[1] At the meeting of the Seventh International Ophthalmologic Congress, held in Heidelberg, August 8-11, 1888, the friendly and highly appreciative Otto Becker presented to each and every attending colleague a copy of his beautiful and interesting "Jacques Daviel, Ein Gedenkblatt"—as a "Festgabe." The frontispiece of this luxurious folio is formed by a beautiful copperplate reproduction of the symbolistic design drawn by Daviel's patient, de Voge—which is above referred to, and, on a diminished scale, herein reproduced. Following, stands an Introduction by Becker, in his usual charming style. Then comes, in a German translation, Daviel's "Bericht über Zwei Angewachsene Staare (Cataractae)"—one of the cases being that of the painter, de Voge, who made the design above-mentioned, the other, that of a certain Madame Foudrillon. Next appears, in French, Hédou's interpretation of de Voge's allegoric design (which I have given above in English) and then the work closes with the poem "par Mr. L. Chr. D. F."

Despite the great advantages of Daviel's invention, the operation of cataract extraction, after a brief preliminary period of almost universal acclaim, passed partly out of favor; and then there began a most bitter contest for precedence between the old procedure and the new. There is little that is memorable about this three-times-thirty years war, which raged from approximately 1755 till nearly the middle of the 19th century. Suffice it to say that the armies of couchment, or depression, were led by Pott, in England, Dupuytren in France, Scarpa in Italy, and Langenbeck, Buchhorn and a number of others in Germany. The leaders of the opposite host were Sharp, Wenzel, Wathen, Warner, Tenon, Pamard, Richter, Beer and Thos. Young. This war was made perhaps a little longer than it would otherwise have been, by the invention, in 1785, by von Willburg, of the modified depression procedure, termed "reclination."

For the sake of completeness merely, I add the following abstract of the most important improvements in, or at least alterations of, the extraction operation, which have been introduced since the time of Daviel:

De la Faye, in 1752, was the first to suggest that the lance and scissors of Daviel be laid aside, and the cut be made with only a single knife.

Sharp, however, of London (April 7, 1753), was the first to carry out De la Faye's idea.

De la Faye himself performed the operation with only a single knife, June 11, 1753.

The single knife "had come to stay." Numerous modifications, however, were made in that instrument in the course of the next six years. Of these the most important were those of Poyet, of Paris (1753); Joseph Warner, of London (1754); Louis Béranger, of Bordeaux (1756); Jacques René Tenon, of Paris (1757); Pamard, of Avignon (1759).

"A very important addition to the technique of cataract extraction was furnished by Himly, who, in 1801, reported the employment of artificial dilatation of the pupil in connection with this procedure. Himly was not the first to bring about an artificial dilatation of the pupil. He was simply the first to produce mydriasis as a preliminary to the extraction of cataract. (See **Himly**.)

The "preliminary iridectomy" was introduced by von Mooren, of Düsseldorf, in 1864. The inventor of iridectomy (but only as a means of forming an artificial pupil, not as a matter connected with the cataract operation) was Beer (in 1798).

One of the most important modifications of the cataract incision was the so-called "linear incision" of Albrecht von Graefe, first performed in 1866.* "It placed the wound in the sclera as near to the iris as possible, and involved iridectomy." The immediate object was to secure an incision which should constitute a segment of that greater circle of the globe of the eye in which lay the points of puncture and counter-puncture. The remoter purpose was to obviate gaping of the wound and suppuration. For the execution of this procedure its distinguished inventor devised also a straight and narrow blade of 2-3 mm. in width, which is still well-nigh universally employed in cataract extraction and still is called "von Graefe's knife." The operation itself, however, was soon modified, and, in fact, to all intents and purposes was soon rejected. For one thing, difficulty was experienced in getting the wound of a sufficient size to permit of the passage of a very large lens. Again, irido-cyclitis, either early or late, and sympathetic ophthalmia destroyed too many eyes that had been subjected to extraction by the linear method.

The intracapsular operation was undoubtedly invented by De la Faye in 1753, developed very assiduously both by Sharp and by Beer, and, very recently, by Smith, of India. Its value is still in question.

On the whole, it is truly remarkable how extremely little of actual, unquestionable merit (aside, of course, from general matters like anesthesia and asepsis) has really been contributed to the senile cataract extraction operation since the days of the genius, Daviel. The drawing of De Voge should hang in the office of every ophthalmologist.

ODE

à M. DAVIEL, CHIRURGIEN OCULISTE DU ROY.

Hé quoi! des mains intelligentes[1])
Dirigent un trait acéré
Dans ces Tuniques transparentes
Dont l'oeil fragile est entouré:
Daviel, guidé par son génie,
Quand le sang trouble l'harmonie
De cet orbe si précieux,
Va sous l'envelope flexible,
Déployant le tranchant terrible,
Porter la lumière des Cieux.

---

* Von Graefe had employed the modified (*i. e.*, combined with iridectomy) linear extraction in cases of soft cataract as early as 1864.

[1] M. Daviel a guéri l'Auteur d'un mal d'yeux considérable, par une opération.

Révérons l'essence première
Qui daigna former de ses mains,
L'organe par qui la lumière
Est transmise aux Humains.
Trois humeurs en l'oeil disposées [2]),
Quelques membranes enchâssées
Composent le corps agissant,
Qui, par sa parole féconde,
Portèrent la clarté du monde
Dans les ténèbres de nos sens.

Soustrait aux ombres ténébreuses
L'homme semble être reproduit:
Il voit ces Sphères lumineuses
Qu'une invisible main conduit.
A ses regards la terre s'ouvre [3]),
L'Univers entier se découvre;
Mais quel effet prodigieux!
Des corps si vastes à sa vue
Tracent leur surface étendue
Dans le cercle étroit de ses yeux.

Mais quand de cet orbe mobile
Le mal vient briser les ressorts,
Quel mortel est assez habile [4])
Pour en ranimer les accords?
Quelle main flexible et légère
Ose trancher en hémisphère
Ce globe privé de clarté;
Et par une audace intrépide
Emporte le cristal liquide
Loin de l'organe épouvanté.

Tel qu'on voit un épais nuage,
Qui long-tems obscurcit les airs,
Poussé par le vent de l'orage
Se dissiper au sein des mers:

---

[2] On sait que l'humeur aqueuse, l'humeur cristalline, l'humeur vitrée et six membranes, forment l'organe de la vue.

[3] Les objets, selon plusieurs Auteurs, se peignent au fond de la rétine, et selon d'autres sur la chorioïde.

[4] M. Daviel fait l'opération de la Cataracte, d'une manière qui lui est particulière et dont il est l'inventeur: il ouvre circulairement la cornée transparente, et extrait le cristallin de la chambre postérieure de l'oeil.

Tel l'oeil voit forcer la barrière
Où mille faisceaux de lumière
Alloient s'éteindre sans retour,
Et déchirer ce voile sombre
Qui par l'épaisseur de son ombre
Lui cachoit le flambeau du jour.

Daviel, quelle lumière sûre
Guide tes pas audacieux,
Le sein profond de la Nature
Se découvre-t-il à tes yeux? [5])
Quoi! frappé par le trait terrible
Le sang dans ses canaux paisible
N'a plus ce cours impétueux,
Dont on vit l'étonnant ravage
Nous offrir si souvent l'image,
D'un oeil sanglant et ténébreux.

Sans doute il respecte l'organe [1])
Où ta main fait entrer le jour;
L'acier tranche en vain la membrane
Rien ne le trouble en son séjour.
Et l'aveugle ouvrant la paupière
Reçoit à grands traits la lumière
Jusqu' alors voilée à ses yeux [2]).
Quel agent? quelle force active
Lui porte cette clarté vive
Qu'il n'obtint pas même des Cieux?

Devant lui tout semble renaître,
Tout frappe, étonne ses regards,
L'astre du jour vient de paroître
Quels corps dans l'étendue épars!
Le nombre, l'ordre, la structure,
D'un Etre auteur de la nature
Lui retracent le souvenir,
Sa surprise en ses yeux est peinte,

---

[5] La manière ordinaire d'opérer la Cataracte est sujette à des accidents terribles qui causent très-souvent la perte de l'oeil, ce qui n'arrive presque jamais dans la nouvelle méthode.
[1] Cette opération se fait presque toujours sans effusion de sang.
[2] M. Daviel a guéri plusieurs aveugles, nés avec la Cataracte.

Par-tout il retrouve l'empreinte
D'un Dieu qu'il doit craindre et servir.

La nuit, il le voit dans l'espace,
Déployant des mondes divers
Fixer à chaque Astre la place
Qu'il doit avoir dans l'Univers.
Qui traça la route éclatante
Que suivent ces célestes corps,
Et l'Art d'une force motrice
Qui meut un si vaste édifice
Sans épuiser tous ses ressorts.

On ne le voit point de sa sphère
Forçant le cercle limité,
Porter une main téméraire
Au voile de l'éternité;
Il sent que sa foible paupière,
D'un Dieu rayonnant le lumière,
Ne peut soutenir la splendeur;
Et que l'humaine intelligence,
Loin de pénétrer son essence,
Doit adorer sa profondeur.

Daviel, que de mortels stupides
Des ombres de la nuit tirés,
Te doivent ces transports rapides
A l'Etre éternel consacrés!
En arrachant le voile sombre
Soudain, des miracles sans nombre
Qui frappent l'orbe radieux,
Portent à leur âme attentive
Cette intelligence si vive
Du pouvoir du maître des Cieux.

Va jusques aux bornes prescrites[3]),
Par les ordres de l'Eternel,
Etendre les vastes limites
D'un Art que tu rends immortel;
Parcours les deux pôles du monde,
Et que ta science profonde

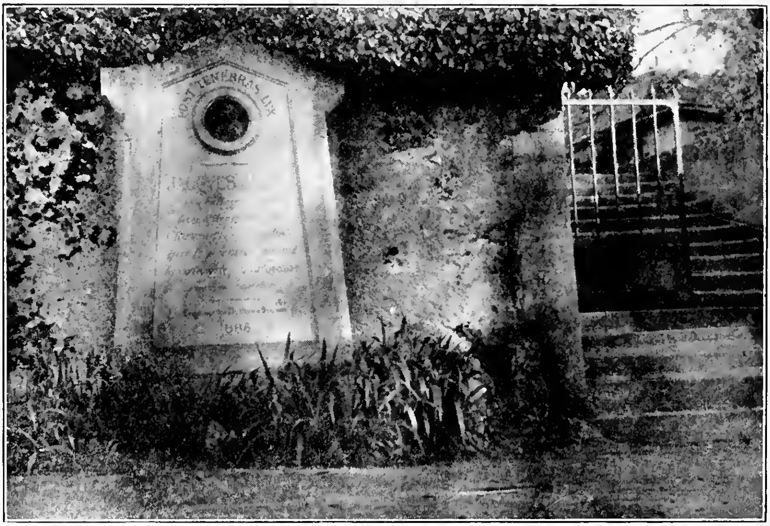
---

[3] M. Daviel a été appelé dans différentes Cours de l'Europe pour diverses maladies des yeux.

Serve à mille peuples divers.
Sois tel qu'un Astre salutaire
Dont l'influence passagère
Se répand sur tout l'Univers.—(T. H. S.)

[This sketch may well be drawn to a close by referring to a visit made in 1910 to the grave of Daviel (near Geneva, Switzerland) by D. W. Greene (*Ophthalmic Record,* Vol. 19, p. 288.)

"In company with Dr. D. Guerfin, a well-known Geneva oculist with whom I had had some correspondence relative to the matter, I



Daviel's Grave, near Geneva, Switzerland.

visited the grave of Daviel at the entrance to the cemetery of the Grand Saxonix Church, about two miles north of the city. Approaching the entrance from the north (which consists of fourteen stone steps with a double iron gate less than half-way up), we face an ivy-covered stone wall about ten feet in height which surrounds the cemetery. To the left of the entrance set in this wall is a marble slab. Near the top we noticed a medallion bust of the master and above it the inscription "Post Tenebras Lux." Below, in French, it is stated that he who first cured cataract by extraction is buried in this cemetery.

This simple headstone, erected in 1885 by the oculists of Switzerland to the memory of Daviel and his achievements, is a humble but grateful tribute to a foreigner, for Daviel was a Frenchman.

In Europe, where monuments are everywhere to be seen commemorative of almost everything that has ever happened, one wonders why one befitting the life and work of this great master does not tower its tip heavenward, to be kissed by the rays of the rising sun as it dispels the darkness and gloom of night, "Post Tenebras Lux," just as the master hand had so often dispelled the darkness and gloom from the eyes of his fellow beings."]

Daviel'scher Lappenschnitt. (G.) Daviel's flap section (for cataract).

Dawson, Thomas. An 18th century English physician, of slight ophthalmic importance. He published "An Account of a Safe and Efficacious Medicine in Sore Eyes and Eye-Lids." (London, 1782, p. 15). The medicine referred to was a salve of the nitrate of mercury—the so-called "yellow ointment." This ointment had been brought to Dawson's attention by a relative, for whom the "yellow ointment" had been prescribed, thirty years before, by a Dr. Nettleton, of Halifax. Though the composition of the salve has been altered (the yellow oxide being now employed in place of the nitrate) the name, "yellow ointment," has remained in general use.—(T. H. S.)

Day-blindness. HEMERALOPIA. FUNCTIONAL DAY-BLINDNESS. Much confusion has resulted from confounding the term *hemeralopia* with *nyctalopia*. It is generally considered that the former name is the proper one to apply to functional day-blindness, and that nyctalopia should indicate functional night-blindness. Day-blindness is a symptom characterized by the fact that patients afflicted with it see better on dark than on bright days. The same state of affairs is true of patients suffering with toxic amblyopia. Hemeralopia occurs in persons who have been long removed from light, and in those who have congenital defects, such as albinism, irideremia, coloboma of the choroid, coloboma of the iris, etc. It is said to be congenital and to be associated with congenital amblyopia. Hemeralopia may be caused by exposure to bright light, such as reflection from snow and ice. Eye-strain from errors of refraction is said to be a cause. Photophobia and dazzling sensations are annoying symptoms.

Treatment will include the correction of errors of refraction or of muscle-balance, the use of smoked glasses, and the administration of tonics. The patient should be instructed gradually to become accustomed to bright light.—(J. M. B.)

Daylight, Artificial. Attempts have recently been made to produce a glass through which it is possible to see the same color values by gas or electric light, as those given by daylight. Eye-glasses of this sort have been developed in the research laboratories of an American lighting company. In many occupations, daylight color values are

essential, and it is the purpose of these "daylight glasses" to permit the use of ordinary gas or electric lighting and still give an opportunity for color matching. Instead of carrying pieces of goods to a window, the woman customer would only need to put on the glasses to judge the colors. The glasses have color screens to absorb the light rays that are not found in daylight. Mercury-vapor lamps are deficient in red rays, causing the green complexion effects that are so noticeable; so with these glasses, it would not be possible to do the color matching under a mercury-vapor lamp.

Day-sight. Hemeralopia.

Dazzling. This term is commonly employed to include all or most of the phenomena and symptoms produced by exposure to strong lights of all kinds. The most pronounced ocular lesions are those due to gazing at electric furnaces, and other high-power electric light, eclipse of the sun, reflections from snow, etc. See, for example, **Eclipse ophthalmia; Electric ophthalmia,** as well as **Blindness, Snow;** and **Conjunctivitis, Traumatic.**

Many writers, among them Schanz and Stockhausen (*Archiv. für Ophthalmologie,* 71, 1, 1910) have published during the last two years papers dealing with the subject of the action of light, especially of ultra-violet light, upon the eyes; and they have introduced a yellowish-green glass, called euphos glass, for the protection of the eye from the action of the ultra-violet rays. Euphos glass absorbs all ultra-violet rays while diminishing but slightly the intensity of the luminous rays.

In the paper under review they record some further observations upon the action of ultra-violet rays upon the eye and discuss at length the part played by these rays in the production of the phenomena of dazzling.

It is well known that ultra-violet rays excite fluorescence of the lens. The authors find that this fluorescence is almost completely prevented by placing between the source of light and the eye a Wood's filter, which, at a certain dilution, absorbs ultra-violet rays of wave lengths between 400 and 375 $\mu\mu$ while allowing those of shorter wave lengths than 375 $\mu\mu$ to pass in almost undiminished intensity. It is therefore rays of a very limited region of the spectrum, those of wave lengths between 400 and 375 $\mu\mu$, that are mainly responsible for the production of fluorescence in the lens.

In a former paper the authors stated that fluorescence of the lens diminished after long exposure to ultra-violet rays. They now attribute this diminution in fluorescence to changes occurring in the

cornea and aqueous since it does not occur, even after prolonged exposure, in the case of a lens removed from the eye.

By spectrographic observations they have determined that rays of wave length less than 375 $\mu\mu$ are absorbed by the human lens to a high degree in youth and completely after middle age. These rays, however, cause little or no fluorescence. Therefore the absorption of ultra-violet rays by the lens is not entirely dependent on conversion of ultra-violet into fluorescent light. A large part of the ultra-violet rays is absorbed without giving rise to fluorescence, and the fluorescence is not proportional to the total amount of ultra-violet light absorbed. Fluorescence occurs also in the retina when the eye is exposed to ultra-violet light. This must be caused mainly by rays of wave lengths from 400 to 375 $\mu\mu$, for rays of shorter wave length are absorbed by the lens almost completely in youth and totally in later life.

The following table is given showing the action of light rays of different wave lengths upon the eye:

VISIBLE RAYS: RED, YELLOW, GREEN, BLUE, VIOLET.	INVISIBLE RAYS: ULTRA-VIOLET.		
I.	II.	III.	IV.
	WAVE LENGTHS.		
760—400 $\mu\mu$.	400—375 $\mu\mu$.	375—320 $\mu\mu$.	320 $\mu\mu$.
Reach the retina unchanged, are invisible	A part is changed into fluorescent light in the lens, a part is absorbed by the latter, a larger part, however, reaches the retina, where it is in part changed into fluorescent light, and in part perceived as lavender-grey.	Take little part in causing fluorescence of lens. They are absorbed to a great extent by the lens, and reach the retina in much diminished intensity only in youth.	Do not penetrate the cornea, but are specially active in exciting inflammation in external eye. Average limit of absorption by glass, 300 $\mu\mu$.

Discussing the influence of ultra-violet rays in producing the symptoms of dazzling, the authors express the opinion that the fluorescence excited in lens and retina plays an important part. It causes blurring of the retinal image, just as diffuse light in a camera causes fogging of the photographic image. It is irritating to the retina, as shown by the brisk pupil and lid-closure reflexes excited by it. It probably causes rapid fatigue of the retina by exhausting the visual substances. These are deleterious influences deserving serious consideration even though it is not proved that they may cause grave lesions.

Long exposure to light rich in ultra-violet rays causes erythropsia and, as shown recently by Birch-Hirschfeld, disturbance of the color sense. The only ultra-violet rays that can be concerned in causing these symptoms are those of wave-lengths from 400 to 375 $\mu\mu$, since these are the only ones which reach the retina in appreciable quantity. Luminous rays may play a part in the production of these symptoms. No sharp distinction can be drawn between the physiological action of the visible and invisible rays; it is the same in all regions of the spectrum, but its intensity is inversely proportional to the wave-length of the rays.

The authors review the principal experimental and clinical evidence with regard to the action of ultra-violet rays on the lens and refer to the possibility that senile cataract may be due to the action of these rays. They admit that there is no proof of this, but emphasize the fact that a large proportion of ultra-violet rays, in daylight as in artificial light, is absorbed by the lens, and that these rays possess very great physiological activity. Birch-Hirschfeld failed to produce lens changes in rabbits' eyes by 150 times repeated exposures of ten minutes' duration to intense ultra-violet light. But the authors consider that these experiments do not in the least disprove the possibility that cataract formation may depend upon relatively rapid wearing out of the lens fibres as the result of life-long action of the ultra-violet rays. In the above-mentioned experiments of Birch-Hirschfeld conjunctival changes were produced similar to those seen in the human conjunctiva in spring catarrh. The authors remark that if spring catarrh is due to ultra-violet rays it must be due mainly to rays of wave-length between 320 and 300 $\mu\mu$, as rays of shorter wave-length are almost wanting in daylight, except at high altitudes, and rays of greater wave-length have but little irritant effect on the conjunctiva.

It is advisable to wear glasses absorbing all rays of wave-length less than 400 $\mu\mu$ for the prevention of snow-blindness and where working by the light of modern lights containing a large proportion of ultra-violet rays; and this too even when the light is of moderate intensity, if the eyes have to be exposed to it for long, because the fluorescence excited in the lens and retina may cause discomfort. The increased clearness of vision in bright daylight obtained by the use of amber glasses is attributed largely to the absorption of ultra-violet rays by these glasses, which prevents fluorescence of lens and retina and the consequent blurring of vision. Euphos glass is recommended as being better than any other for this purpose since it possesses the highest power of absorption for ultra-violet rays, while only slightly

reducing the intensity of luminous rays. Euphos glasses are also recommended for cataract glasses. Axenfeld has ordered them for glass-blowers after operation for cataract, and patients wearing them have been able to resume their work, whereas formerly such patients had to seek other occupations. Axenfeld and Schanz have found this glass useful in cases of retinitis pigmentosa and for the relief of photophobia. Euphos-grey glass is now prepared for use in cases where it is required to diminish the luminous rays as well as the ultra-violet.

The paper concludes with a criticism of Volgi's experiments, who attempted to prove the harmlessness of modern lamps by showing that the proportion of ultra-violet rays in the light emitted by them is no greater than in ordinary diffuse daylight in Hamburg. The authors point out that the Wood's filter used in his experiments absorbs rays of wave-lengths from 400 to 375 $\mu\mu$, just the rays which cause fluorescence of the lens and retina and play the greatest part in the phenomena of dazzling. (W. H. McMullen in *Oph. Review*, June, 1910.)

Birch-Hirschfeld (Graefe's *Archiv für Oph.*, 71, 3) describes at considerable length the effect on the eyes of rabbits of frequent exposures at intervals of about two days to light rays of short wave-length and comparatively low intensity. The source of light was the Schott mercury vapor lamp used for about ten minutes at a distance of ten centimetres. A single exposure with everted lids resulted in an acute conjunctivitis developing about five hours later and persisting for about five days. The discharge contained great numbers of eosinophile cells. As the result of frequent exposures the conjunctiva developed a milky appearance with rough papillary elevations. Microscopical examination showed that the conjunctival epithelium had assumed the characters of epidermis and had even, in those cases submitted to very long exposures, developed pigment in the deeper layers. The connective tissue showed hyaline degeneration, which did not, however, appear to affect the elastic fibres. Plasma cells were present in considerable numbers. The small blood-vessels exhibited both hyaline degeneration of their walls with considerable thickening, progressing in some cases to obstruction of their lumen, and endothelial degeneration associated not infrequently with healthy walls. These appearances closely corresponded with the changes described as occurring after the use of radium, Roentgen rays, high-frequency currents, and in spring catarrh. No pathological changes were found in the cornea, lens, or retina. The changes in the conjunctiva were only produced if the lids were everted.

The author points out that although the histological changes produced present many points of resemblance to those met with in spring catarrh, yet they can hardly be regarded as specific for that affection. Moreover, in contrast to the changes met with in spring catarrh, those produced experimentally were found to vanish without leaving any trace after the lapse of a few months. It was also noteworthy that in the case of the rabbit no individual hypersusceptibility to the influence of light could be discovered. The experiments may be considered to have some bearing on the liability to relapse of spring catarrh under the influence of sunlight, but to negative the view that sunlight is the primary cause of that affection.

Attention is called by Vogt (*Arch. fur Augenheilk.*, Vol. 74, p. 41, 1912; Vol. 75, p. 227, 1912) to the voluntary production or suppression of scotomas caused by gazing with one eye continuously at a bright surface, like a white cloud, or paper or snow in strong sunlight. While so gazing after a few seconds, pale-pink, with alternating greenish and yellowish tints appears at the centre of the field; followed by a sudden darkening of an area 30 or 40 degrees in diameter, which may be made to alternate with the bright surface fixed, by action of the will choosing which will be seen. Vogt supposes this scotoma is due to a change in the cones, which can be voluntarily recognized or overcome. This phenomenon he regards as essentially the same as the streaming or glimmering appearance described by Nagel as seen after looking fixedly at bright lines on a dark ground. Isakowitz (*Klin. Monatsbl. fur Augenheilk.*, Feb., 1913, p. 213) has experienced a sensation of dazzling when reading about dazzling objects, which might become so vivid as to render the page indistinct.

A star-shaped after-image of unusual origin is described by Hoppe (*Arch. fur Augenheilk.*, Vol. 73, p. 274, 1912). Entering a dark Alpine hut on a bright summer morning, and looking through the window at the sky, he saw a star-shaped figure made up of separate bright flecks arranged in radiating lines and elongated in the direction of the rays; the figure from the right eye differing slightly from that from the left. This appearance he ascribes to the inner layers of the retina or the immediately adjoining vitreous.

Deadly nightshade. A vulgar name for the atropa belladonna.

Dead-man's-hand. A vulgar name for male fern, or *aspidium felix mas.*

Deafness, Ocular relations of. It would, at first blush, seem probable that the visual and auditory organs, so intimately associated so far as cerebral origin and locality are concerned, must be influenced by the same or similar agents. As a matter of fact few organs in the human organism have so little in common as those that compose the

ocular and aural apparatus; indeed, it is quite ususual, for instance, to find disturbances of function or alterations of tissue of the eye affecting the hearing. The practice of otology and ophthalmology by the same medical man, common enough in America at least, is at most an artificial arrangement and may be explained by conveniences and sentiment, rather than by the rules of natural association. There are, however, a few points of contact between these two specialties that will be briefly considered here. Thus, it might be mentioned, in passing, that *suppurative processes within the ear producing deafness*, such as mastoiditis and its cerebral involvements—meningitis, cerebral abscess, intracranial thromboses, etc.—are occasionally productive of oculo-muscular pareses, optic neuritis and choked disc.

The graver forms of mastoid disease, with cerebral, meningeal and sinus involvements, have been already referred to under **Choked disc** (see Vol. III, p. 2074 of this *Encyclopedia*), and the reader is referred to that section for an account of these complications.

Ocular conditions in the deaf and dumb have been investigated by Snegireff. In addition to 100 cases examined by himself, he includes the statistics of others, making in all 891 cases. He found that retinitis pigmentosa, atrophy of the optic nerve, congenital amblyopia and hemeralopia affected about 12 per cent.; corneal alterations were present in 5.2 per cent., strabismus in 3 per cent. and cataract in 1 per cent. Diseases of the lids and conjunctiva were present in nearly 4 per cent. Eyes in the mentally defective has also been the subject of a paper by Clark and Cohen.

A systematic examination of ninety-four deaf-mutes between the ages of 4 and 20 has been made by De Mets (*Bull. de la Soc. belge d'ophtal.*, No. 29, p. 131, 1910). No case of pigmentary retinitis was found. Sixty-seven of the patients were emmetropic in both eyes, the general visual acuity was above normal, and there was practically no case of asthenopia.

Kardo-Lyssoieff (*Wiestnik Oftalm.*, Nov., 1911) has reported on the vision of deaf-mutes in the deaf-mute and blind institution at Warsaw. Ninety-seven boys and sixty-five girls, aged from 9 to 20 years, were examined. The results of examination showed considerable differences from those found in normal schools. Two per cent. proved myopic (1 per cent. of these among the boys and 3 per cent. among the girls), 42.5 per cent. were hypermetropic (46 per cent. boys and 39 per cent. girls), 27.5 astigmatic (21 per cent. boys and 34 per cent. girls), and 20 per cent. were anisometropic (17 per cent. boys and 23 per cent. girls). In the hypermetropic cases brachycephaly was common; in the astigmats, irregular shape of the head, and in

the anisometropes, asymmetry of head and face. In five cases a perceptible microcephaly was found. Most of the cases of hypermetropia, astigmatism and anisometropia showed a congested fundus; two of these showed pseudo-papillitis. Deficiency of pigment was noted in 18 per cent. of the boys and in 26 per cent. of the girls; there was no complete albinism, but it was noted five times in varying degree. In four cases partial optic atrophy was observed, in one of these in association with tower-skull. Chorio-retinitis was present once, and in four cases there was epicanthus. Nystagmus occurred in one girl. Three boys had strabismus. As to the vision this was normal or better in 50 per cent. of the boys and in 39 per cent. of the girls; above ½ in 30 per cent. and 33 per cent. respectively, below ½ in 14 per cent. and 15 per cent., below ¼ in 6 per cent. and 12 per cent.

Van der Hoeve (*Klin. Mon. f. Aug.*, 51, I, April, 1913, p. 461) examined a family of six children, of which the third, fourth and sixth were deaf-mutes and showed changes of the fundus. The oldest boy had atrophy of both optic nerves ($V = \frac{1}{2}$) and retinitis punctata albescens, as shown by a large number of round, yellowish-white dots, mostly at the upper portions of the retina, leaving the macula free—all characteristic of the disease described by Fuchs. Its occurrence in a deaf-mute strengthens its near relation to retinitis pigmentosa. The sister, aged 4, showed atrophy of the optic nerves, thin vessels, numerous similar yellowish-white dots, but more retino-choroiditic foci, a combination of retinitis punctata albescens and atypical retinitis pigmentosa. The third child (with blue iris) when 1½ years old, showed greyish discs, vessels attenuated, and albinotic foci in the fundus.

Of the three other children the oldest had a markedly albinotic fundus, a blue iris, and $V = I$; the second presented a brown iris, fundus albinotic at the periphery, hemeralopia, $V = I$. The parents were related. The father had a sister, a dwarf, and an idiotic brother with convergent strabismus and defective hearing.

Van der Hoeve does not accept Stein's hypothesis of a trophic centre of the eye in the cochlea, after destruction of which changes of the fundus pigment occurs. He found no pigment changes in the eyes of four children in the same family, who had acquired labyrinthine deafness in the eighth year, and concludes that in congenital labyrinthine deafness pigment changes in the eye occur frequently but very rarely in acquired labyrinthine deafness, and that it has not been shown that both anomalies are interdependent. He emphasizes the necessity of examining the eyes of all deaf-mutes.

Van Lint (*La Policlinique*, Feb., 1911) has made many observations and comparisons of the fatigue of visual acuity in normal and deaf-mute children.

K. L. Stoll (*Lancet-Clinic*, CIX, p. 437, 1913) draws our attention to a probable relation between sympathetic ophthalmia and some forms of deafness.

Dean, H. Johnson. A well-known ophthalmologist and oto-laryngologist of Muscatine, Iowa. He was born in Muscatine, Feb. 10, 1869, the son of Dr. and Mrs. H. M. Dean. After his graduation from the high school at Muscatine, he attended for a time the State University. His medical degree was received from Jefferson Medical College, Philadelphia, Pa., in 1890. He was resident physician at the Jefferson Medical College Hospital in 1891, and, later, resident physician to the Orthopedic Hospital and to the Infirmary for Nervous Diseases, also in Philadelphia. He was Clinical Assistant at the Wills Eye Hospital, Philadelphia, from 1893 to 1898.

In 1898 he returned to his native town, in which he practised as ophthalmologist and oto-laryngologist until his death, which occurred April 26, 1910. At the time of his decease he was Eye, Ear, Nose and Throat Surgeon to the Hershey Memorial Hospital, Muscatine, Iowa.

Dr. Dean was a member of numerous medical societies and other scientific associations. He was a good companion, a loyal friend. He was very gentle in the sick-room, yet, withal, extremely firm—"the hand of iron in the glove of silk."

Besides his widow, he left his father and mother, Dr. and Mrs. H. M. Dean, and two brothers, Dr. Lee Wallace Dean, of Iowa City, and Dr. H. Dean, of Washington.—(T. H. S.)

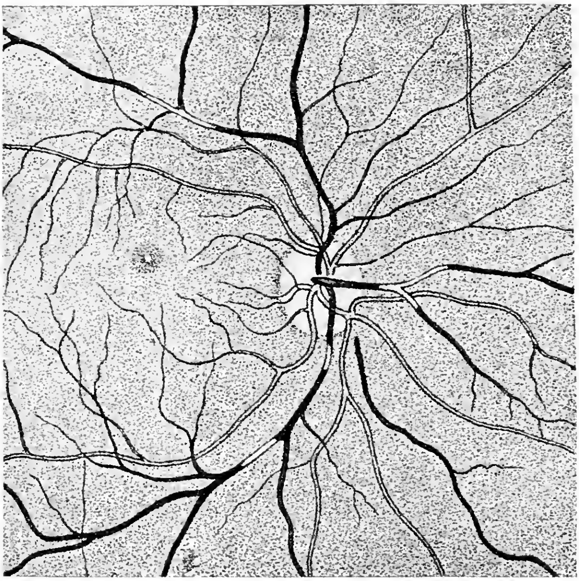
Death, The ophthalmic relations of. Postmortem ophthalmoscopy. Ocular signs of death. The chapter in *System of Diseases of the Eye*, Vol. 4, p. 907, gives a good account of this subject. In it Gayet points out that, according to Poncet, the most certain evidence of death is the general coloring of the fundus of the eye (which is red during life and yellowish at the instant of death) and the anemic condition of the papilla. He found that the arteries disappear, and the veins are reduced to small, irregular and filamentous lines. Weber noted the division of the blood-column and the slowing of the blood-current, but he scarcely ever saw the arteries empty themselves. In other cases he found that death occurred without being preceded by any visible alteration in the retinal circulation. To this communication Becker added that, having examined many fresh eyes in the bodies of those who had recently died, he noticed that the arteries

were full of blood. These citations were confirmed by Gayet. He examined the eyes of five decapitated people, and found the above symptoms as long as the condition of the cornea permitted a view of the fundus of the eye. In four an orange-yellow tint of the fundus was recognized—a condition which was noted by Bouchut. Three times the arteries were almost empty, once empty on the papilla itself. The veins were full at the periphery, but their blood-columns were broken even in this situation. Gayet believed this to be due to an infiltration which takes place along the vessels and in their sheaths. He also often noted a red spot in the macular region which he believed himself to have been the first to describe as one of the series of ocular changes found after death. This, he thought, should be classed with the phenomena that are observed in embolism of the central artery of the retina. In a decapitated white rabbit the retinal vessels were full of blood ten minutes after the fatal blow, and showed the same relations to one another in regard to color that they did during life. After half an hour the arteries were less full, and there was no alteration in the venous circulation. Examination of cadavers shortly after death gave no other results than those mentioned. In a phthisical patient seen one hour after death the fundus became yellow and the retinal vessels disappeared upon the disk. Examination during the period of coma demonstrated a considerable disproportion between the calibre of the arteries and that of the veins. A young man dead of typhoid fever, and kept in a temperature of ten degrees centigrade, showed retinal vessels that were full of blood two hours after death. Finally, a man of seventy-eight years, who was kept for six hours at a temperature of from six to ten degrees centigrade, showed retinal vessels that were normal.

Groenouw (*Trans. 36th Ophth. Congress,* Heidelberg, 1910) found that the mydriatic effect of atropin and the miotic effect of eserin were produced on the eyes until about five hours after death. He suggests that this is a test of the time of death which may have forensic importance.

Morris H. Kahn (*Medical Record,* May 3, 1913) quotes Kobert *(Lehrbuch der Intoxication)* as saying that the pupils in the cadaver are usually dilated, but may in certain cases of poisoning (with belladonna, hyoscyamus, stramonium) be enormously dilated. Abnormal narrowness of the pupil in the cadaver occurs in certain cases, but by no means regularly, after poisoning by morphine or opium. After the internal administration of poisons which on instillation cause a contraction of the pupil (muscarine, pilocarpine, physostig-

mine, arecoline, nicotine) no case of pronounced miosis in the cadaver has ever yet been observed. In the study made by Kahn, when mydriasis was present, examination was made as usual with the electrical ophthalmoscope. Both the direct and indirect methods were employed. When the pupils remained contracted after death, they were dilated with a few drops of a solution of atropine or homatropine.



Postmortem Fundus Oculi. (Kahn.)

As was noted by Groenouw, this is feasible before iridal rigor set in, viz., three to four hours after the patient ceased to breathe. In several cases the mydriasis brought about for the purpose of antemortem examination was taken advantage of in further study. Postmortem, the column of blood in the retinal vessels, sustained and solid, undergoes a change which manifests itself within a limited time.

This change consists of the formation of transverse interruptions in the red color of the vessels, giving the appearance of division or striation of the blood column. These interruptions, often only few in number, are apparent chiefly in the veins and occur both near the disc and distant from it. They occur less constantly in the smaller vessels. While looking at the fundus of the eye, or during the course of frequent repeated examinations of it, one notices, from

time to time, a distinct variation in the length of one or other striation. This can be made more evident by turning the head of the subject from side to side. It can be still more accentuated by pressure upon the eyeball, in both these ways modifying the retinal intravascular pressure. Firm external pressure upon the eye empties the veins in the region of the disc and also the central artery. Upon relaxation the vessels refill to their former capacity. These manipulations for a time after death, alter the size of the interruptions considerably. After about one hour no spontaneous alterations in size are noticeable. After a longer time, i. e., about three hours, the vascular striations are no longer influenced by manipulation and pressure. These phenomena are sometimes more manifest in one eye than in the other.

The presence of this phenomenon, Kahn believes, is dependent on intravascular coagulation. Segmentary in occurrence, with consequent shrinking of the fibrin, this leads to the formation of intercoagular spaces containing serum. The clots in the vessels contract, and thus separate in places from each other, leaving between them the serum which is expressed in the process of congealing. In a number of cases the intercoagular intervals were not observed. In these cases, probably clotting of the distal arterial column took place *en masse;* and the serum that otherwise formed the intercoagular interval, was expressed murally. In a few of the cases presenting choked discs, no intercoagular intervals were found. Here the above-enunciated explanation is the more maintainable, drawing support from the idea that the central pressure favored coagulation *en masse.* It is likely that it is the adhesion of the fibrin to the vessel wall that finally prohibits variation by pressure, of the size of the intercoagular spaces.

An obvious analogy applies when we consider clotting in the large vessels of the trunk. On examination of these, the clots are found to be, so to speak, in segments, with serum in the intervals. When one carefully observes the peritoneal surface of the intestine postmortem or after resection, he may see that the small vessels, chiefly the venous radicals, present the interruptions corresponding to the intercoagular spaces. This appearance, due to intravascular clotting, may be found intravitam in embolism or thrombosis of the mesenteric vessels. See, also, **Legal relations of ophthalmology,** in the middle third of the section.

Debilitas visus. (L.) A term for amblyopia, or weak sight.

Debuscope. CHROMEIDOSCOPE. ANORTHOSCOPE. A form of kaleidoscope having two mirrors placed at an angle of 10°. See Vol. I, page 503, of this *Encyclopedia*.

Decagon. A plane figure of ten sides and angles.

Decahedron. A solid of ten faces.

Decalcification of eye specimens. In the preparation of microscopical and other eye sections calcification or ossification renders the sectioning with the microtome difficult or impossible. In order that sectioning may be done the specimen must be decalcified. Lime deposits may occur in all portions of the eye. Perichoroidal ossifications are very common after inflammations. Calcareous deposits are frequent in gliomata of the retina, and ossifications in sarcomata of the choroid have been occasionally observed.

The best fluids for decalcification are:—

Müller's fluid.—Müller's fluid will decalcify, provided the specimens be left in the solution long enough. It decalcifies very slowly, and it will be necessary to permit the specimens to remain in it for months.

Picric acid.—Picric acid in a concentrated aqueous solution decalcifies slowly because it does not penetrate into the tissues deeply. The same is true of picro-nitric acid.

Method of Haug.—This method is well adapted to decalcify the tissues of the eye, especially if the specimens have been fixed in formol or sublimate: Nitric acid, 3.0 to 9.0 c. cms.; absolute alcohol, 70.0 c. cms.; distilled water, 30.0 c. cms.; sodium chlorid, 0.25 c. cm.

Phloroglucin method.—Phloroglucin, 1.0; nitric acid, 5.0; alcohol, 70.0; distilled water, 30.0.

The above solution decalcifies rapidly. The time required for complete decalcification varies with the amount of calcareous material to be removed and the thickness of the specimen. To ascertain if the decalcification is complete, we pick the area of the deposit with a teasing needle. After the calcareous deposit has been removed, the specimen should be washed in water for several days.

If the condition remained unnoticed until the specimen was mounted for sectioning, it should be placed in equal parts of absolute alcohol and ether to dissolve the celloidin and then should be decalcified. —(J. M. B.)

The Editor has found *Perenyi's fluid* most useful in decalcifying the heads of birds and for hardening the orbital contents preliminary to their preservation in alcohol for subsequent sectioning.

Decangular. Having ten angles.

Decentered eyes. This term was used by Javal to describe minor degrees of keratoconus, because he thought this deformity depends upon an unusual size of the angle Alpha (q. v.) See, also, **Conical cornea,** Vol. IV, p. 2976 of this *Encyclopedia.*

Decentered lens. A lens thicker at one side than at the other; in effect one so mounted that the visual line does not pass through its center.

Decentering. The process of so mounting a lens that its optical centre is not directly in front of the pupil.

Decentration. In *optics*, the amount which the principal axis of a lens is displaced parallel to the visual line of the eye, or the line of collimation in a centered optical system. Prentice (*Archives of Ophthalm.*, Vol. XIX, No. 1 and 2, 1890) thus states the law of decentration: Any lens is capable of producing as many prism-dioptries as the lens possesses dioptries of refraction, provided it is decentered one centimetre.

Savage (*Ophthalmic Myology*, pp. 208-210) says that when focal errors require either convex or concave lenses, these can be decentered so as to give the necessary prismatic effect. For esophoria, convex lenses should be decentered out and concave lenses should be decentered in. The same rules for placing prisms should govern the decentering of lenses. It would seem that authors ought to agree as to how much a given lens should be decentered in order to obtain a definite prismatic effect, but they do not. Maddox teaches that a lens of 1 D must be decentered 1.75 cm. (17.5 mm.) to obtain 1° of prismatic effect. He then gives the following formula for determining the extent of decentration of any lens for a required effect: $C = \frac{P \times 1\frac{3}{4}}{D}$, in which C is the centimetres of decentering; P, the desired prismatic effect; and D, the number of dioptres in the lens. Let $P = 1\frac{1}{2}°$ and $D = 3°$, then the formula would be: $C = \frac{1\frac{1}{2} \times 1\frac{3}{4}}{3}$ = .875 cm., or 8.75 mm., which is about $\frac{1}{3}$ of an inch of decentering.

Jackson teaches that the following formula is practically correct: $C = \frac{P \times 10}{D}$, in which C is the mm. of decentering required; P, the prismatic effect desired; D, the number of dioptres in the lens to be decentered; while 10 is the mm. of decentering of a 1 D lens for 1° (1 centrad) of effect. Substituting figures for letters, as in the

Maddox formula, we have: $C = \frac{1\frac{1}{2} \times 10}{3} = 5$ mm., or about $\frac{1}{5}$ of an inch of decentering, as compared with Maddox's $\frac{1}{3}$ of an inch of decentering.

Thorington and May agree in taking 8.7 mm. for the extent of decentering a 1 D lens in order to procure 1° of prismatic effect. For obtaining the amount of decentration of any lens, this would be their formula: $C = \frac{P \times 8.7}{D}$. Substituting figures for letters, as in the other formulas, we have: $C = \frac{1\frac{1}{2} \times 8.7}{3} = 4.35$ mm., or about $\frac{1}{6}$ of an inch of decentration, as compared with Maddox's $\frac{1}{3}$ of an inch and Jackson's $\frac{1}{5}$ of an inch; or, comparing in mm.: Maddox, 8.7; Jackson, 5; Thorington, 4.35; May, 4.35. By a little experimentation the reader may satisfy himself that Jackson is practically correct. The extent of decentration advised by Maddox is entirely too much—nearly double what it ought to be. It may be that Maddox's estimate was for 1° of arc, and not for 1° of prism, or 1 centrad.

One advantage that decentering a lens has over the grinding of a lens on a prism is that the former is cheaper; another advantage is that the wearing of a decentered lens is not attended by the reflected image of any bright object, which is always toward the refracting angle and in the line of the axis of the prism, unless the prism is ground on both surfaces. Chromatic aberration is no more, nor is it any less, with a decentered lens than it is with a lens ground on a prism. The great objection to decentered lenses is that the spherical aberration must interfere to some extent with the sharpness of retinal images; this, however, is but little when the decentering is 6 mm. or less, and rarely is it more. In very strong lenses, say 6 D, the decentering would be only 5 mm. for 3° of effect.

The greatest objection to "relieving prisms" and to decentered lenses is that they favor muscles in their weakness. They lessen nervous tension, but not by increasing the inherent power of weak muscles. It is far better practice to increase the inherent power of weak muscles, either by exercising them or by shortening or advancing them, or to increase the relative power of the weaker muscles by lessening the tension of their stronger antagonists by partial tenotomies. If patients will not resort to exercise and decline to submit to

operations, they should be given the benefit which is to be derived from prisms in positions of rest or from decentered lenses.

Decentration, Prism. See **Decentration.**

Déchiré. (F.) Lacerated. Torn.

Déchirure de la choroïde. (F.) Rupture of the choroid.

Deckel. (G.) Cover.

Deckganglienzellschicht. (G.) The ganglion-cell layer of the retina.

Deckglas. (G.) A cover-glass for a microscope slide.

Deckpunkte. (G.) Corresponding retinal points.

Declination, Negative. In cyclophoria or cyclotropia a tilting of the vertical meridian towards the left is called levotorsion or negative declination.

Declination, Retinal. A term, first used by Geo. T. Stevens to indicate the relation of the retinal meridians in cyclophoria and other oculomuscular defects. It is practically the same astronomical and physical word, employed to indicate an inclination from a zero point, and is measured in degrees, minutes and seconds.

Declinator. Declinometer. An instrument used for the measurement of declination of the ocular meridians, or torsion of the eyeball.

Declinograph. A recording declinator.

Decoctum ophthalmicum mucilaginosum. (L.) A name for decoctum altheæ, a preparation made by boiling varying proportions of marshmallow root and water.

Decoctum rutæ zincatum. (L.) This preparation was once popular as *eau d'Alibour* or *eau d'Yvel pour les yeux.* It is made by boiling 61 parts of rue in 734 of water till reduced one-half, adding 30 of zinc sulphate and 11½ of copper sulphate, and, when these are dissolved, 1⁹⁄₁₀ of camphorated brandy; or by triturating 5 parts of camphor and 2 of saffron with a little water, adding water enough to make 1,227 and 38 each of sulphates of zinc and copper, and filtering.—(Foster.)

Décollement. (F.) Separating or freeing from adhesions. Detachment.

Décollement de la rétine. (F.) Detachment of the retina.

Décollement de l'iris. (F.) Iridodialysis.

Décollement rétinien. (F.) Detachment of the retina.

Decolor. Decolorate. To bleach, or remove the color from.

Decoloratio argentea. (L.) Argyriasis. Argyrosis, or staining by silver salts.

Décoloré. (F.) Colorless.

Decolorized tincture of iodine. See **Iodine.**

Decomposition of light. The separation of a beam of light into its spectral colors; as, in the rainbow. Artificially produced through refraction by a prism, or reflection from a *diffraction grating* (which see). The latter produces a spectrum of about equal areas of red, blue and violet, which is called the *normal spectrum.* See **Spectrum.**

Decompression, Cerebral. Although this subject has already been discussed, on page 2100, Vol. III, of this *Encyclopedia,* yet additional observations may here be given.

An interesting paper has been contributed by George Robinson (*Ophthalmology,* January, 1909). He thus describes the results of decompression in a case of dioptric neuritis in which the swelling of the papilla in the worse eye equaled 7 dioptres. The operation of decompression was advised and the subdural space was opened in the occipital region, by J. Thompson Schell, on each side by means of a trephine. These openings were connected by removal of the intervening bridge of bone with the Rongeur forceps. Upon removing the button of bone on the right side, the dura bulged outward, and the incision was followed by the escape of a considerable quantity of cerebrospinal fluid. No growth was demonstrable. Upon opening the left side, the dura did not show evidences of internal pressure; there was no escape of fluid nor the presence of a growth.

In three days' time the patient reacted well. He had had only one or two attacks of headache since, and these very mild. He fixed with either eye, the excursion outwardly being much improved; diplopia being present only upon strong abduction. With the ophthalmoscope the swelling of the optic discs had greatly reduced (+ S. 3 D. to + S. 4 D.), their borders being still obscured and the retinal edema subsiding. The patient left his bed and felt comfortable. There was some improvement in gait, although the patient was weak. The ocular excursions were still improving. There was no diplopia upon strong effort in any direction. With the ophthalmoscope, the apex of the disc could be best seen with + S. 2 D., the vessels being better defined and of relatively normal size. The retinal edema was very much reduced. There were but a few small hemorrhages on the disc. There was a small vitreous opacity in the right eye. The margins of the disc were hazy.

Three days later the patient was discharged from the hospital. Examination at this time showed perfect ocular excursion in all directions, there being binocular single vision. Esophoria equaled six degrees; vision equaled 15/xl. On October 2 vision equaled 20/lxx and 20/xl partly. The esophoria had been reduced to three degrees. On Oct. 12, 1908, vision equaled 20/xl and 20/xxx partly. The apex of the disc was but + S. 1 D. to + S. 2 D. A saturated

solution of iodid of potassium in increasing doses three times daily was ordered.

The course of this case seems to the author to confirm the opinion of Horsley, that simple opening of the calvarium is not sufficient, but should be associated with free incision of the dura. There are two places where the cerebrospinal fluid is held by the arachnoid, in the form of a cisterna, which can readily be approached: (1) the interpeduncular cisterna by way of the squamous portion of the temporal bone, and (2) by the subtentorial route through the occipital bone, attacking the cisterna beneath the cerebellum.

"Few things," says Horsley, "are more striking after operation for intracranial tumor than to see the rapidity with which the swelling and degenerative changes of the disc and retina clear up. Certainly it seems to occur with the same rapidity whether the operation is performed above or below the tentorium."

The location of the tumor may be determined by the age of the neuritis being upon the side where the changes have advanced the more, regardless of the amount of swelling. The degree of atrophy may be considered a guide to the prognosis of the amount of relief afforded by an operation. Neurologists generally are agreed that decompression is usually associated with subsidence of choked disc, regardless of the continued presence and growth of the tumor.

In conclusion the writer believes with Horsley, that the question of the saving of sight, even in people who are the subjects of a fatal disease, is so important as to include all classes of cases: (1) those in whom it is possible to remove tumors and get them well; (2) those who have meningitis and recover, and (3) those who have malignant disease and ultimately succumb.

Horsley (*Ophthalmoscope,* Sept., 1908) further thinks that all these cases of optic neuritis should be relieved as soon as possible by operation. The operative treatment, in the absence of other indications, should be opening of the subdural space in the temporal or subtentorial region. The attending physician must be held responsible for consequent blindness if the neuritis be not thus relieved as soon as possible.

In this connection Edward Stieren (*Ophthalmic Record,* p. 150, 1908) properly says:

"In predicting the degree of vision that will be attained, much depends upon the ophthalmoscopic picture before operation. If signs of degeneration of the retina, especially in the region of the macula, are present, the prospects are usually not of the best for recovering a useful degree of vision. Edema of the nerve, moderate edema of

the retina with small hemorrhages, exudates along the course of the vessels and even larger exudates not in close proximity to the macula, need not deter us from expecting good results, for it has been demonstrated that these lesions disappeared or did not seriously interfere with vision after the retinal circulation had again been established."

A case of decompressive trephining for bilateral choked disk is reported by Robinson (*Ophthalmology,* Vol. 5, p. 179, 1909). The swelling of the disk in the right eye amounted to 7 D.; in the left eye it was less. There was paralysis of both external recti and some ataxia with tendency to walk to the right, which was taken to indicate tumor of the right cerebellum. Trephining was done on both sides and the dura opened. In three days the swelling of the nerve heads had subsided about one-half. In a month it remained between 1 and 2 D., and vision had risen from 20/100 to 20/40, and from 20/50 to 20/30 partly.

Fehr (*Centralbl. f. p. Augenheilk.,* pp. 78, 197, 1909) reports the case of a 16-year-old girl who had suffered from headache, and presented a partial abducens paralysis and moderate choked disk with vision still normal. Under mercurial and other medical treatment and lumbar puncture the abducens paralysis became complete on one side and almost complete on the other. The swelling of the disks increased, the visual fields contracted and central vision declined. Trephining with incision of the dura was followed by improvement in all respects. The movements became normal, the field of vision increased and vision rose from 5/30 and 5/20 to 5/10 and 5/6 in six months. In a case reported by Cabannes (*Ann. d'Ocul.,* Vol. 142, p. 77, 1909) a man aged 53 had suffered Jacksonian epilepsy six years and failing vision four years. Vision had fallen to right counting fingers at 1½ metres, and left light perception. There was advanced post-neuritic atrophy. But after trephining, with partial removal of the tumor (a psammoma), vision improved within six months to counting fingers at nearly 4 metres.

The first case of deliberate surgical intervention (subtemporal decompression) in a case of uremia, with the idea of its being a pressure phenomenon is reported by Cushing and Bordley (*Am. Jour. of Med. Sc.,* October, 1908). The patient was a woman, aged 22, with chronic diffuse nephritis (small granular kidney) and a blood-pressure above 230. On ophthalmoscopic examination the swelling of the optic disc was 6 and 7 D. The whole surface of the retina was covered with hemorrhages and exudates. A number of lumbar punctures gave no evidence of benefit. After subtemporal decompressive craniectomy the systolic blood-pressure at once fell from 300 to 210.

The headaches subsided; there was no further nausea or vomiting and the stupor rapidly disappeared. Ten days after the operation the swelling of the disc did not exceed 1 D. and the retinal condition had greatly improved. Her general condition was so much improved that the patient left the hospital against advice. Two weeks after her discharge she was re-admitted with a cerebral hemorrhage, from which she died.

The marked improvement after cerebral decompression in this case adds further evidence in support of Taube's hypothesis (favored by Bramwell, Russell and others) that the cerebral symptoms in the so-called uremia are largely due to pressure from edema of the cerebral tissue.

It goes to show, furthermore, that albuminuric neuro-retinitis is a local edema of mechanical origin.

The *Ophthalmic Year Book* in its last three issues has abstracted several papers on this subject. We quote parts of these. Saenger (*Jour. Amer. Med. Assn.*, Sept. 24, 1910, p. 1100) gives the results in twenty-six cases in which cerebral decompression was performed for cerebral tumor. Seven were of the cerebellum. In one of these there was a cyst, the removal of which resulted in a cure. Three were tumors of the acoustic nerve. In a case of tumor of the parietal lobe a hernia resulted and the patient lived for nine months with good vision. In three there was a tumor of the frontal lobe. In one there was choked disk on the opposite side. Three were tumors of the base and decompression was without result. In two cases of cerebral tumor the only result was removal of headache and vomiting. The patients had been blind before the operation. In a case of supposed tumor of the cerebellum the patient died of hemorrhage immediately after the operation. Necropsy showed only a chronic meningitis. In five other patients presenting choked disk and the other usual symptoms of brain tumor, no tumor was found but the choked disk and tension symptoms disappeared after decompression.

Scheffer and De Martel (*Ann. d'Ocul.*, Vol. 143, p. 476, 1910) record a case where the patient had the classical symptoms of intracranial tension with papilledema. Trephining without removal of the dura was performed, and there followed a complete recovery which has persisted. In Souques' case (*Ann. d'Ocul.*, Vol. 143, p. 294, 1910) there was right monoplegia and bilateral papilledema. Trephining over the left hemisphere was performed and was followed by right hemiparesis with transitory aphasia. The original condition was much improved but a slight papillitis with normal vision persists. Baker (*Ohio State Med. Jour.*, May, 1910) urges operation after mer-

cury and potassium iodid have failed. Harris (*Ophth. Record,* Vol. 19, p. 457, 1910) observed double papillitis in a man who several weeks before had been struck over the right eye by a board. On trephining, an abscess containing a fragment of wood was found in the frontal lobe. Immediate recovery was good, but eighteen months subsequently repeated, frequent convulsions occurred and have since continued.

Posey (*Ophth. Record,* Vol. 19, p. 185, 1910) reports on the subsequent condition of a patient with neuro-retinitis of chlorotic origin. There was a moderate degree of optic atrophy and, in one eye, considerable retino-choroidal disturbance between the disk and macula. The same author reports a case of unilateral papillitis in a young man, a worker in rectified spirits. As the patient was otherwise healthy the cause was attributed to alcoholic toxemia. From personal experience resting on the fundus examination of every patient who has fallen under his care for many years, Hawthorne (*Brit. Med. Jour.,* July 23, 1910) is unable to number more than six instances of the association of optic neuritis with chlorosis. Uno (*Klin. Monatsbl. f. Augenheilk.,* Mar., 1910, p. 411) states that in his case of trephining, vision continued to fail for some time after the operation but finally improved. Antisyphilitic treatment was used.

Lloyd and Spellissy (*Jour. Nerv. and Ment. Dis.,* Vol. 38, May, 1911) record a case of cerebral decompression of five years' standing, in which a large cerebral hernia resulted with marked improvement in optic neuritis. Before the operation there was marked choked disc, with probable left homonymous hemianopsia and symptoms indicating a lesion in the right Rolandic area. A large osteoplastic flap was made in this region but no tumor was present. A large hernia, probably of the membranes alone, resulted. Later convulsions of a Jacksonian type developed. Five weeks after the operation no change had occurred in the papilledema, but four months later it had largely disappeared. Five years after the operation there was marked post-neuritic atrophy. V. = 4/15. Von Hippel (*Klin. Monatsbl. f. Augenheilk.,* Jan., 1911, p. 83; July, 1911, p. 47) reports seven cases of palliative trephining for choked disc. He urges ophthalmologists to endeavor to convince the general practitioner that it is not admissible to treat patients who show symptoms of intracranial pressure with indifferent methods, including inunctions of mercury and the iodid of potassium until vision deteriorates. The early diagnosis of choked disc must be made and surgical treatment instituted much more frequently than heretofore.

From a further study of reported cases of palliative operation for

choked disc von Hippel says that a double choked disc is an immediate indication for surgical interference, to be done even though function is normal. Radical operation can be undertaken earlier than heretofore if the diagnostic cerebral puncture finds more extended use. But the majority of cases of choked disc can still be treated only palliatively. Permanent drainage of the ventricles is not practicable, because of technical difficulties in the way. Lumbar puncture if tumor is suspected is contraindicated. Puncture of the corpus callosum, can lead to permanent cure of choked disc. It is particularly indicated in the early stage with normal function. If it fails in three or four weeks trepanation can be performed. Theoretically the puncture of the corpus callosum is indicated more in marked hydrocephalus, and trepanation more in solid increase in the content of the skull. In a number of cases in which a surgical operation was done, either for decompression or removal of a tumor, ophthalmoscopic examinations were made at several and varying periods after the operation. After trephining without incision of the dura the changes were usually inappreciable. When a tumor was removed, the results as regards choking of the disc varied from none to rapid reduction of the swelling. In one case a pronounced network of fine vessels on the disc disappeared rapidly after removal of a tumor of the occipital lobe. On the basis of this case in which the most marked swelling occurred, where the tumor made pressure on the sinuses, as well as of the fact that papillary stasis is sometimes confined to one side, the author favors the mechanical theory of causation.

Velter (*Arch. d'Opht.*, Vol. 31, p. 129, 1911) believes that it is necessary to perform decompression, after mercury and lumbar puncture have been tried, so soon as stasis is seen to be progressive. It is never too late to operate, even in complete blindness. In the absence of localizing symptoms the operation should be made in the right subtemporal region. The dura had better not be incised at first. If a second operation becomes necessary it can then be done. Complete cure is obtained only in cases operated upon early, before atrophy has set in. Although the operation always relieves the patient, the operative prognosis and the visual prognosis vary according to the case and the cause of the hypertension. Reber (*N. Y. Med. Jour.*, Jan. 27, 1912, p. 184) editorially reviews the present status of decompression for the preservation of vision. He quotes the elder von Hippel as favoring the education of the general practitioner to believe that in the absence of symptoms of syphilis that symptoms of

increased intracranial pressure accompanied by choked disc justify surgical intervention.

Danis and Geerts (*Soc. Belge d'Ophtal.*, No. 33, p. 72, 1911; *Ophthalmology*, Vol. 9, p. 305, 1911) report a case in which decompression was done for tumor of the pons cerebellar angle. Deafness and difficulty of speech had existed three years and weakness of the hands eight years, before disturbance of vision led to the discovery of choked disk. Trephining, without opening the dura, was followed by improvement of vision, which lasted several weeks, although the disks were becoming atrophic. The condition then grew worse, and death from hemorrhage occurred on reopening the scar.

Archibald Church (*Railway Surgical Jour.*, p. 73, 1913) urges that in nearly every case where a decompressive operation is to be done, a careful study of the patient will indicate the advisability of operating in a certain region; that is, a careful study of localizing symptoms and signs will justify using the parietal, the occipital, or the frontal region, on the right or the left side, so that the opening may be made first of all for decompression, secondly for exploration, and sometimes what is equally important in the third place, that if there be a subjacent neoplasm, by opening in the area near it the tumor will move towards the opening so that the operation will finally result in an enucleation, which would be impossible without the preliminary decompression.

The personal experience of G. E. de Schweinitz (*Annals of Ophthal.*, April, 1911) represents an investigation of about seventy-five operations. When the decompression operation is indicated it should not be postponed until vision has been permanently reduced from atrophic change in the optic nerve. When this stage is reached the operation sometimes seems to hasten the visual failure. Usually the choked disc does not occur until the intracranial neoplasm has existed for some time. When the papilledema comes on suddenly or suddenly increases, it is probably because the brain tumor has gained rapidly in volume, or there has been a hemorrhage in or around it, or for some unknown cause the intracranial pressure has been suddenly increased. When there is no choked disc, but there are other symptoms of brain tumor, the retinal veins may be found to be enlarged, and the color fields may be reversed, this being true only when the intracranial pressure is increased. A careful mapping out of the blind spot may also show that it is enlarged and spindle-shaped. Another interesting symptom of brain tumor is temporary amaurosis, which may last from a few moments to a few hours. It depends upon pressure on the chiasm from the third ventricle. Where the above symptoms are

present the advisability of doing a decompression operation is strengthened. After injuries to the head the ophthalmoscope should be frequently used, and if papilledema develops it is one of the indications for trephining. The greatest care should be taken to differentiate between true papilledema and a spurious optic neuritis due to an error of refraction. It is always highly important to know whether there is an error of refraction, and the vision with error corrected. In syphilitic brain tumors the decompression operation is indicated after antisyphilitic treatment has been given a fair trial. The author does not advise the operation for choked disc associated with uremia. Care should be taken to eliminate uremia as a cause of papilledema, especially where the latter is believed to be due to a brain tumor.

A report on fourteen cases of palliative trephining or decompression is published by A. von Hippel (*Klin. Monatsbl. f. Augenheilk.*, July, 1911). In none was a localization of the disease possible, although all were carefully examined at the neurologic clinic. Generally an opening of the size of a 50-cent piece was placed in the parietal bone, in three cases only in the temporal bone, and the dura incised at once. If the brain bulged, puncture of the ventricle was made. The skin was carefully sewed. In two cases large encephalocele followed the rapid growth of the tumor. Although some cases were operated upon after the disease had existed for years, there was no immediate death after the operation. Hence von Hippel considers the danger of the operation under the improved technic very slight, so that it can be conscientiously recommended. In two out of nine cases operated on at the left side, aphasia occurred, so that the right side ought to be given preference, if the affection cannot be located in the left side.

The papillitis completely subsided in all cases which remained alive for a longer time, and in others constantly decreased until death. The time in which the first improvement could be distinctly observed ophthalmoscopically, fluctuated between two and seventeen days. Twice the papillitis subsided more rapidly on the side of the operation, although the previous swelling had been the same on both. This speaks in favor of the opinion of Horsley that the intracranial pressure may be different in the two hemispheres, and for his advice of operating on the side on which the papillitis first develops. Moreover, from the experience of von Hippel, palliative trephining is undoubtedly the most valuable remedy for papillitis, if performed in time, i. e., before considerable deterioration of vision or atrophic discoloration of the disc. In eight of his patients V, from 3-10 to 1

before operation, remained unaltered or was improved; in the others V, reduced to counting fingers at 1 or 2 M., could not be saved in spite of the subsidence of papillitis; seven out of the fourteen cases are still living. In four not only the papillitis was cured but all other symptoms of increased cerebral pressure have entirely disappeared; two lost the very violent headaches and one suffered from headache only at night, but in all three the papillitis was cured, vision preserved and the general condition very much improved. The autopsies of five cases revealed glioma or sarcoma, and in a child with hydrocephalus, tuberculous meningitis.

Uhthoff (*Klin. Monatsbl. f. Augenheilk.*, Mar., 1913, p. 369) records two instances in which favorable results followed operations for papilledema. No tumor was found in the first case notwithstanding that a deep incision was made in the substance of the frontal lobe on the left side—the area in which the lesion was localized. Three months later all neurological symptoms had subsided and the optic nerves were nearly normal. In the second case there was a bilateral papilledema and left hemichromatopsia. A puncture of the cerebrum and corpus callosum was made. All the symptoms improved and further operation, which was indicated, was declined. The lesion appeared to be in the region of the visual radiations of the occipital lobe. He makes a plea for the immediate report of all cases in which operations are done. Von Hippel and Goldblatt (Graefe's *Arch. f. Ophth.*, Vol. 86, p. 170, 1912) give the notes of thirty-six cases of papilledema in which palliative operations were performed. Of twenty-three cases with useful vision, ten died while under observation, the earliest on the third day, the last at two and one-half years. Puncture of the corpus callosum alone was done fourteen times and in seven cases it was done before trepanation. In two instances radical operations were performed. Complete regression of the papilledema without atrophy followed the puncture operation six times. In one case there was marked atrophy. Of the seven cases in which a cure of the papilledema resulted, one died in two, and a second in three, months. The others are still living. Of the thirteen cases with poor vision, seven died, the earliest four days after operation, the latest fourteen months. Of these thirteen cases the puncture operation was done alone seven times. Trepanation followed in three. The visual results were strikingly bad, as was to be expected from the condition existing at the time of the operation. They conclude that the surgical treatment of papilledema is today the normal procedure. Of the methods which give results puncture of the corpus callosum has a high place. As the slightest operation with the least danger it is to be

recommended when the operation can be done at the proper time, that is, the earliest stage of the edema. If it fails for the papilledema, a further operation can be done, in general, under more favorable conditions of the intracranial tension, whereby its danger is lessened. If the early stage of edema is passed then trepanation is to be done at once.

Decorso. (It.) The course or progress (of a disease).

Decortication. The removal or stripping of the exterior or cortex from an organ (the brain, for instance) in experiments on animals.

Découpé. (F.) Incised.

Découvert. (F.) Naked. Uncovered.

Décroissance. (F.) Diminution. Decrease.

Decurve. To curve downwards.

Decussatio nervorum opticorum. (L.) Chiasm.

Decussation of the optic nerve. Chiasm.

Decussatio tractuum opticorum. (L.) Chiasm.

Decussazione degli nervi ottici. (It.) Decussation of the optic nerve.

Dédaigneux, Muscle. (F.) The external rectus muscle of the eye.

Deep keratitis—. This term is used to contrast the various infections and inflammations of the superficial layers of the cornea with more serious lesions involving the *substantia propria.* They may be divided into suppurative deep keratitis, ulcerative deep keratitis, deep non-suppurative keratitis, and deep punctate keratitis.

Deep stroma plexus of the cornea. This term indicates the rich and intricate plexus of nerves supplied to the anterior three-fourths of the cornea proper.

Défaut. (F.) Defect.

Defective color-vision, Unrecognized. It is a remarkable fact that many people pass through a good part of their lives, without being aware of the fact that they are color-blind. In a majority of cases, they do not themselves discover it. See **Color-sense and color-blindness.**

Defects in the visual field. This subject will be fully discussed under the caption, **Field of vision.** Here it may be said that defects in the visual field (including scotomata) are of two kinds, first, the physiological blind spot and, second, pathological defects.

The blind spot is found 15° to the outside of and 3° below the point of fixation.

Pathologic defects may take the form of concentric contraction, hemianopsia, sector-like defects, or scotomata. Hemianopsia (half-sight) can often be made out by a rough test, such as the use of the hand. The other defects require careful perimetry. *Scotomata* are areas of partial or complete blindness lying within the field of vision.

They are divisible into positive and negative, true and false, central, paracentral, ring, and peripheral. A positive scotoma is present as a cloud which obscures vision in a certain direction and is due to retinal disease. A negative scotoma is a space in which objects naturally are unseen by the individual in health. The physiologic blind spot forms a negative scotoma. True scotomata are due to lesions in the brain, optic tracts, optic nerve, or retina, while false scotomata are caused by the obstruction arising from the presence of a blood-clot, an opacity in the dioptric media, or a new formation floating in the vitreous body. Such a defect changes its position with every movement of the eyeball. Central scotoma is due to retinal or choroidal disease; the toxic action of alcohol, tobacco, and other substances capable of producing amblyopia; or to a form of neuritis involving the optic nerve behind the globe. Such scotomata are mapped out with difficulty because of impaired fixation.—(J. M. B.)

Defects of refraction and accommodation. See **Refraction and accommodation.**

Defectus corneæ pelluciditatis. (L.) Opacity of the cornea.

Defensive proteids. The term applied by Hankin to those substances formed in the bodies of animals that render them immune to certain diseases. See Vol. II, page 857 of this *Encyclopedia*.

Defining power. See **Definition.**

Definition. The accurate focusing of the rays proceeding from an object-point to the corresponding image point.

Deflection. Inflection. A bending of the rays of light.

Defluxio ciliorum et superciliorum. (L.) Falling out of the eyelashes and eyebrows.

Defluxion. Rapid falling, as of the hair or eyebrows.

Deformities, Congenital. See **Congenital anomalies of the eye.**

Degeneracy of the eye. This term is variously interpreted and applied, not only to any organic lesion of the ocular apparatus causing its partial or total obstruction but to racial influences and, still more frequently, it is used synonymously with **Congenital anomalies of the eye.**

Degeneratio-adiposo-genitalis. (Frölich.) A condition (opposed to that of giantism or acromegaly) in which there is tumor of the hypophysis without the usual ocular and other symptoms of acromegaly. A more complete account of the matter is given by Sutherland Simpson (*Ophthalmology*, page 485, 1913) in his paper on the physiology of the *hypophysis cerebri*.

Degenerazione amiloide della congiuntiva. (It.) Amyloid degeneration of the conjunctiva.

Dégonflement. (F.) Collapsing; usually said of a tumor or swelling.

Degrade. In *optics*, to lower in position in the spectrum; to increase the wave-length of a ray of light, and, hence, to diminish its refrangibility, as by the action of a fluorescent substance. See **Fluorescence.**

Degree. In *trigonometry*, a unit for measuring circular arcs and the angles subtended by them at their centres, being the 360th part of a circumference, or the 90th part of a right angle. Considered as angular magnitudes, all degrees are equal; considered as arcs, they are directly proportional to the radii of the circles of which they are parts. This manner of dividing the circle originated with the Babylonians about 2000 B. C., and was brought into use in Greece by the mathematician, Hypsides. The common abbreviation or sign for "degrees" is a small circle (°) placed at the right of the top of the last figure of the number of them: as, 45°. The degree is subdivided into 60′ (minutes), and the minute into 60″ (seconds).—(C. F. P.)

The *designation of the degrees* in astigmatism was the subject of a set of resolutions by the International Medical Congress at Naples in 1909 and were to graduate the lower arc of the trial frame commencing for each eye from 0° at the nasal side of the patient, to a graduation of the upper arc, placing 0° on the nasal end of the horizontal meridian of each eye and 180° on the temporal end. This has not been sufficiently published so that the desired uniformity has not been generally adopted. R. Greeff (*Klin. Monatsbl. f. Augenheilk.*, March, 1910) advocates, in settling such matters, collaboration with representatives of wholesale optical companies, whose members are more familiar with the practical side of the question. He reprints a letter from an optical expert who emphasizes the great advantages of commencing on the left side of the patient with 0° for each eye, which corresponds with the graduation of ophthalmometers and was proposed at the Naples congress by Ovio, but not heeded.

Dehais-Gendron, Louis Florentin. Born in the early part of the eighteenth century (exact date unknown) at Orleans, France. He was the nephew of the celebrated surgeon, Claude Dehais-Gendron, received his medical education at Montpellier and settled in Paris. In 1762, he was made Professor and Demonstrator of Ophthalmology in the School of Surgery.

The most important of Dehais-Gendron's writings was *Traité des Maladies dex Yeux et des Moyens et Opérations propres à leur Guerison* (2 vols., Paris, 1770). This work was sorely needed at the time of its appearance—for nothing resembling a comprehensive text-book on ophthalmology had then appeared in France since the *Nouveau Traité*

of St. Yves, in 1722. It remained in favor for more than forty years. —(T. H. S.)

Dehiscent cataract. An obsolete term used to describe a soft, lenticular cataract in which there are gaps or spaces between the opacities.

Dehydration of sections. In preparing microscopical specimens paraffin sections are placed in 60 per cent. strength alcohol for a few minutes, then in 90 per cent. strength alcohol, and finally in absolute alcohol.

Celloidin sections are dehydrated in 95 per cent. strength alcohol, since absolute alcohol dissolves the celloidin. If the celloidin has stained as intensely as the tissue,—for instance, after staining with anilin dyes,—it may occasionally be necessary to remove the celloidin. This is accomplished as follows: The section is treated with absolute alcohol for about five minutes and then is placed in a mixture of absolute alcohol and ether (equal parts) for from ten to fifteen minutes. Oil of cloves will also dissolve the celloidin, but it must be removed again by pure xylol.—(J. M. B.)

Deidier, Antoine. A French general surgeon of the eighteenth century, who had considerable reputation as an oculist.

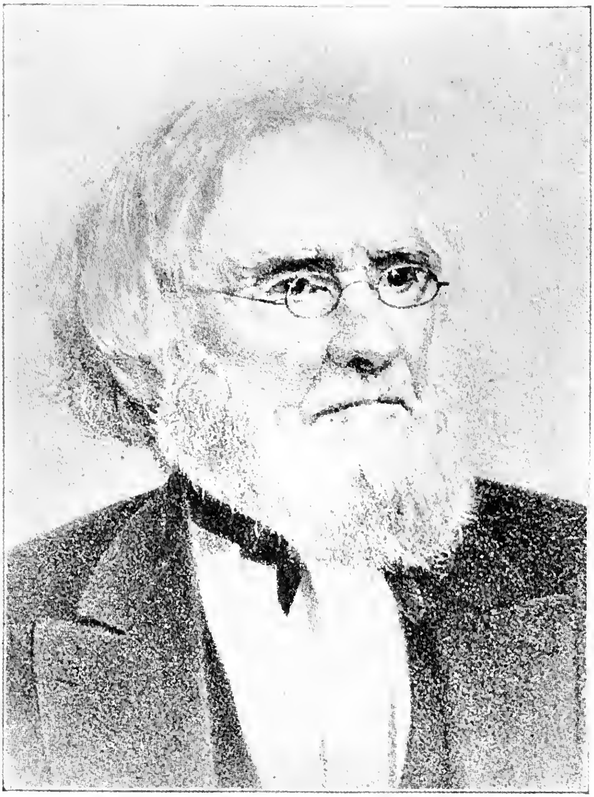
He received his medical degree at Montpellier in 1691, and was immediately appointed to the chair of chemistry in that institution. In 1720 he was sent to Marseilles to treat patients suffering from the pest. In 1732 he returned to Montpellier, where, four years later, he died.

His most important works are: 1. *Chimie Raisonnée.* (Lyons, 1715.) 2. *Anatomie Raisonnée du Corps Humain.* (Paris, 1742.) 3. *Consultations et Observations Médicinales.* (Paris, 1754.)

Among his "Consultations" occur the following on oculistic subjects: "Upon a Lachrymal Fistula," "Upon an Ophthalmia," "Upon an Incipient Gutta Serena," "Upon an Involuntary Running of Tears," "Upon an Enfeeblement of the Sight, Consecutive to a Blow with a Sword," "Observations upon a Cancer of the Eye."

A case of sympathetic ophthalmia Deidier explained as follows: "The blow of the sword, received in the left eye, suddenly deranged this organ, and troubled in it so strongly the course of the blood that this liquid was obliged to carry itself an hour afterward in too great quantity to the right eye, where it involved the optic nerve for three months, during which time it was not in a condition to transmit the impressions of objects to the brain, and was the cause that the patient remained completely blind until the blood of the right eye had, little by little, resumed its natural course and released the optic nerve."—(T. H. S.)

Delafield, Edward. A famous American obstetrician and pediatrist, who devoted considerable attention to ophthalmology. Born in 1795, he received the degree of Bachelor of Arts at Yale College in 1812 and his medical degree at the College of Physicians and Surgeons in the City of New York in 1815. In company with Dr. John Kearney Rogers he studied for a time in Europe, and, after his return to New



Edward Delafield.

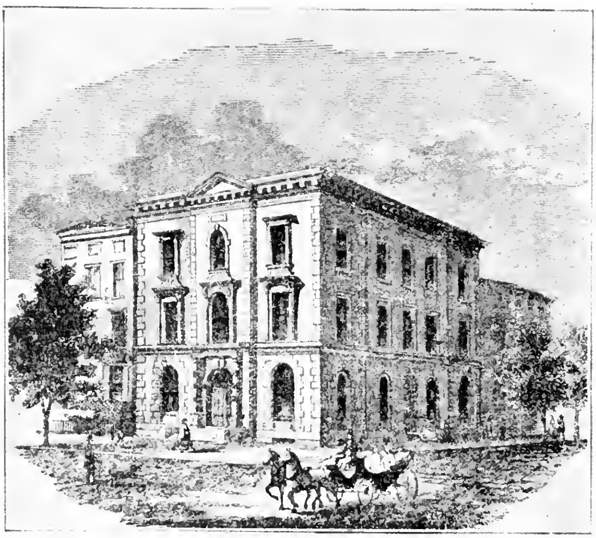
York, these two men together organized (1820) the New York Eye Infirmary. Here he practised as ophthalmologist, and lectured on diseases of the eye for many years.

He wrote but little, being far too busy with other matters. A few reports by him, however, appear in the early volumes of the American Ophthalmological Society, of which he was one of the founders. He also edited one American edition of *Travers on the Eye.*

For a very long time he held the chair of obstetrics and pediatrics at the College of Physicians and Surgeons, and was widely known as a skilful practitioner of both of these specialties.

He was a very courteous man, made numerous friends and held them till the close either of their lives or of his own.

He died Feb. 13, 1875.—(T. H. S.)



New York Eye and Ear Infirmary, Erected 1856.

Delafield's hematoxylin. Four hundred cubic centimetres of a concentrated aqueous ammonic-alum solution is mixed with a solution of four grams of hematoxylin in twenty-five cubic centimetres of absolute alcohol. The mixture is exposed to the light in an open vessel for three or four days; 100 cubic centimetres of methylic alcohol and 100 cubic centimetres of glycerin are then added, and the stain is allowed to mature. In a few days it is filtered and is ready for use.

Staining.—1. Sections are washed in water (or 1 per cent. strength alum solution). 2. Sections are stained for from two to three minutes; if the stain has been diluted with water, ten to fifteen minutes. The section should have a light-blue tint, not an intensely dark one. 3. Wash in water until no more blue color is given off (for from ten to fifteen minutes to several hours). 4. Dehydrate in 95 per cent. strength alcohol. 5. Clear in carbol-xylol. Balsam.

If a section has been overstained in hemalum or hematoxylin, the desired tint may be obtained by the following procedure: Place the

overstained section in $\frac{1}{10}$ per cent. strength muriatic acid until it turns red, then wash the section thoroughly in water for several hours. Should the section be still overstained, the procedure can be repeated until the proper tint is obtained.—(J. M. B.)

Delamination. A splitting apart. Arranging in layers.

Delarue, François. Born at Mauzot, Puy-de-Dôme, France, about 1785 he studied medicine at Paris, and there received his medical degree in 1810. He settled in Paris, became physician to the Bureau of Charity, and gave free medical lectures especially on diseases of the eye. Among his writings the most important are: "Avis sur le Traitement des Maladies Vénériennes, etc." (Paris, 1816); "Mém. sur les Bons Effets des Attouchements avec la Pierre Infernale, etc." (Ib. 1823); "Le Vade-Mecum ou Guide de Chaque Complexion pour Prolonger la Vie" (5 ed., ib. 1829).

His only ophthalmologic composition is "Cours Complet des Maladies des Yeux, Suivi d'un Traité d'Hygiène Oculaire" (Paris, 1820). This work lacks very much of being a "Cours Complet," exhibiting as it does vast lacunæ where important matters ought to be. Nevertheless, it is clear, succinct, and, so far as it goes, highly practical.

The date of Delarue's death is not procurable. He is known to have been alive in 1840.—(T. H. S.)

Delayed implantation. This is a term employed by Webster Fox (*The Ophthalmoscope*, January, 1909) to denote a substitute for Mules' operation, where enucleation has to be performed. His method of performing this operation is to make the incision through the orbital tissues in the superior nasal angle. Through this opening a pocket is made in the tissues lying underneath the centre of the orbit. Into this pocket a gold ball, 12 to 14 mm. in diameter, is inserted. The orbital opening is not sutured, but is pressed together by a conformer which also serves to hold the gold ball in position in the centre of the orbit. See **Enucleation.**

Delay's test for simulated blindness. See Vol. II, page 1177, of this *Encyclopedia.*

Delhi boil. A synonym of Aleppo boil. See Vol. I, page 217, this *Encyclopedia.*

Delirium after ophthalmic operations. Although delirium is rare after cataract extraction and other operative measures yet it does occur. See Vol. III, page 1745 of this *Encyclopedia.*

W. R. Parker (*Trans. Sec. Ophthalm., A. M. A.*, June, 1913) gives an account of eleven cases and tells us that the first description of post-operative psychoses dates back to the sixteenth century when Para called attention to the occurrence of mental symptoms after

operations. In 1819 Dupuytren described a "delirium nervosum" which occurred in the first three days after an operation, and in 1842 psychoses after eye operations were reported by Sherzog. Sichel in 1863 described a peculiar delirium which he had observed seven or eight times in the wake of cataract operations. All the patients were over 60 years old. He attributed it to sealing the lids and thought the mental effect similar to homesickness. Arlt wrote in 1874: The second eye is uncovered before the fourth day only when the patient becomes restless because of darkness. In old patients, much run down, timid and nervous, mental disturbances may occur during the first few days after the operation.

The writer further states that delirium occurred in 0.29 per cent. of the cases operated on. No patient showed marked signs of mental disturbance while under observation, either before or at the time of operation. One case showed possibility of infection from an old cystitis. The urine was free from sugar, albumin or casts in nine cases. No record was made in two cases. Codein was administered in two cases, one grain hypodermically, immediately after the operation. The possible effects of cocain can be eliminated, as the mental disturbances did not occur in a single case until at least twenty-four hours after the time of operation, and there was no rise in temperature.

Delivery. See **Obstetrics, Ocular relations of.**

Delivery of the lens. The act of removing or extracting the crystalline lens from the interior of the eye and its appearance externally. See Vol. III, page 1643 of this *Encyclopedia.*

Dellen (Fuchs). See **Cornea, Pitting of the.**

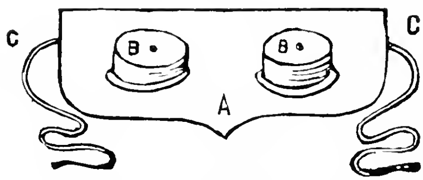
Delpech, Jacques Mathurin (1777-1832). One of the pioneers of orthopedic surgery, and the first (in 1816) to perform a subcutaneous section of the tendo Achilles. He studied for the most part in his native city of Toulouse, but received his doctor's degree at Montpellier in 1801. In 1813 he became a professor in Montpellier. In this city, too, he erected, at his own cost, an orthopedic institute in which he exhibited a well-nigh incredible activity in surgical orthopedics. One day, while on his way to this institute, in which he had done so much for science and humanity, he, as well as his coachman, was shot and killed by a patient on whom he had operated for varicocele. The horses, running away, brought the carriage, with its two dead occupants, to the very gates of Delpech's orthopedic institute.

Delpech's more important writings are: *Clinical Surgery at Montpellier* (1823-28) and *On Orthomorphia* (1829). Though he wrote but little relating to the eye, he is to be remembered by ophthalmologists, because, by his orthopedic operations in general and his subcutaneous

tenotomies in particular, he let down the bars into a field in which Dieffenbach soon worked to the lasting advantage of humanity—the field, namely, of the surgical treatment of strabismus.

We may add the following summary of what had been accomplished in all the preceding ages in the way of the *non*-surgical treatment of the affection in question.

Paul of Ægina (625-690 A. D.): "The congenital squints of children are cured by the application of a mask in such a way that the little ones look straight forward. (Because squint is a cramp of the muscles which move the eyeball.) A lamp should be set exactly opposite the eyes, and not be permitted to shine from the side. If the child still turns the eye toward the nose, a red lock of wool should be glued to the temporal corner, so that the child, looking at this attentively, may cause the eyes to become straight."



The Strabismus Spectacles of Ambroise Paré.

The only improvement (or, rather, mere unimportant alteration) which was made by the Arabs in the method described by Paulus was this—to hang a black flap over the sound eye, thus necessitating the exercise of the strabismic eye.

Ambroise Paré (1509-1590) recommended spectacles containing horn disks, in the centre of each of which was a hole. (See illustration.)

Eschenbach, indeed, in 1754, made the following remark (in his work on surgery) which possesses an historical importance. "Ophthalmologists have imagined that squint might perhaps be curable by the section of one or another of the ocular muscles."

Taylor, the famous English quack (1708-1768), speaks of having actually performed such sections, but, in truth, he "operated only with his mouth."

Then came Delpech, with his wonderful subcutaneous tenotomies. The bars were down.

Into the field entered, first, Stromeyer, who, in 1839, at Hanover, performed the first actual section of an ocular muscle on the human cadaver.

In the very next year, Dieffenbach, at Berlin, performed the first actual section of an ocular muscle in the eye of the living subject. This important event occurred Oct. 26, 1839, and was promptly reported in the *Medicinische Zeitung*, Vol. VIII, No. 46.

However (and strangely enough) neither Stromeyer nor Dieffenbach performed a tenotomy, but a musculotomy.—(T. H. S.)

Delphinium consolida. Knight's spur. Lark's heel. Stavesacre. The only preparation of this plant that has been used in eye diseases is the fluid extract of the flowers, which has been recommended as a collyrium in simple conjunctivitis.

Del Toro's operation. This procedure was employed in *conical cornea*, and consisted in destroying the apex of the cone by means of a white-hot knife.

Dementia, Ocular relations of. Acute dementia occurs—but very rarely—after cataract extraction. When this symptom arises death is not an uncommon termination of the case. See **Cataract, Senile,** at the end of the section.

The dementia attending choked disk from brain tumor is the subject of a paper by de Ridder (*Arch. d'Opht.*, p. 578, 1909), who finds that the character of the hallucination may assist in determining the seat of the tumor.

Dementia paralytica. See **Paresis, General.**

Dementia præcox, Eye syndrome of. Tyson and Clark (*Archives of Ophthal.*, Vol. 41, p. 223, May, 1912) give the results of their examination of 115 consecutive cases. They found definite changes and symptoms in all genuine cases of this psychosis. The fundus changes, as seen clinically, are divided by them into three groups, which are usually in the order of their occurrence, as follows: 1. Congestion of discs, hyperemia and edema, dilated dark-colored veins, slightly contracted arteries and blurring of the edges of the discs, all varying in degree. These changes constitute a low grade of perineuritis of the optic nerve. 2. Congestion of the nasal side, with temporal pallor of discs, dilated veins, contracted arteries. 3. Pallor of discs, dilated veins, contracted arteries. These changes constitute anemia and partial atrophy of the optic nerve. All the different forms of dementia præcox were met with, and, while the results by form-types have not been fully analysed, the authors state that the more marked changes in the eye syndrome were found in the more rapidly deteriorating types of the disease. Coincident with the study of the changes in the papillæ the pupils were examined in 85 cases. The average size of the pupils was about 5 mm. as compared with rather under 4 mm. of the healthy controls. The light reaction was active in 71 cases and slug-

gish in 14. Consensual reaction was active in 68 cases and sluggish in 17. Accommodation and convergence reaction were active in 71 cases and sluggish in 13. Hippus was present in one case. The sensory pupil reflex was slightly positive in 6 cases and negative in 79 cases. Pilz-Westphal reaction was positive in 2 and negative in 85 cases. Corneal sensibility was diminished in 69 cases and normal in 17.

The visual color fields were examined in 81 cases. All were found concentrically contracted. The authors sum up as follows: The changes in the discs, pupils, visual fields and corneal sensibility which, when taken together, constitute the new syndrome, are all in accord with each other. In our examination of all other types of insanity, imbecility or idiocy we have found no other condition similar to what we have outlined here for dementia præcox.

They consider that this syndrome is a distinct contribution to the theory that dementia is an autotoxic disease, and that the poison is primarily vascular, which finally induces neuronic degeneration. It points to a toxin of some sort, which is either a metabolic defect in the tissues (ductless gland defect) or what seems more probable, that the poison is generated in the liver or in the gastro-intestinal canal itself. They also consider that the eye symptoms have a prognostic value, as the severer grade of eye changes are found in the more rapidly deteriorating cases.

The *pupillary disturbances* in this disease have been further studied by a number of observers. From a consideration of his own experience of over 200 cases, and of the views of other writers, Bumke arrives at the following conclusions: The average size of the pupils in cases of dementia præcox is larger than the normal; and the diameter of such pupils changes with abnormal frequency and rapidity. In rare cases of catatonic stupor a catatonic rigidity of the pupil is observed, combined with mydriasis or miosis or with various changes of pupillary shape. The pupillary anomaly which is pathognomonic of dementia præcox is the absence of pupillary mobility, of psychic reflex, and of reflex dilatation to sensory stimulation, with retained light reaction. This symptom once developed is constantly present; at the height of the disease is found in more than half of all cases; and is almost never lacking in deeply demented patients. It is practically never present in mania, depressive insanity, or in functional psychoses, but is found in other dementias due to cerebral changes. Weiler and Pförtner (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 544, 1909) call attention tö the significance of the same symptom group. In four cases of dementia præcox Meyer (*Berl. Klin. Woch.*, Vol. 47, No. 40, 1909)

produced pupillary dilatation by pressure on the iliac point: the light reflex was absent so long as pressure was maintained, and reappeared when the pressure was withdrawn.

Demi-aponévrotique. (F.) Semi-membranous.

Demicircle. A simple azimuth instrument, embracing a magnetic compass, alidade and graduated semicircle.

Democritus of Abdera. (About 470 B. C.) A Greek philosopher, the teacher of Leucippos, and the founder-in-chief of the Atomistic theory, which is the corner-stone of modern chemistry and physics.

He is chiefly remembered for this "Atomistic theory." That theory was, in brief, that the entire universe is composed of extremely minute bodies, which are not merely invisible, but also indivisible (hence, the name a-tom). The qualities of none of these atoms can ever be changed, but only their position. According to the arrangement of the atoms, the various sorts of substances are produced, as well as the various processes, or visible changes, which occur in and among those substances.

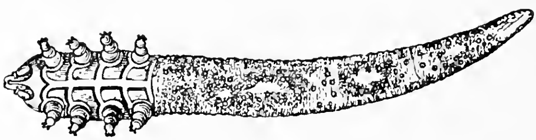
Democritus dissected many individuals of numerous species of animals, and published a work on the anatomy of the chameleon. He studied the pulse in great detail, theorized upon the cause of epidemics, and developed very largely the physiology of reproduction and of all the special senses, particularly sight.

His theory of the nature of vision is extremely interesting. It is, of course, a natural outgrowth from, or corollary to, his atomistic theory of the universe. In his view, the soul itself, as well as the various (perhaps one might say, according to him, other) portions of the body, is composed of atoms—only that the atoms of the soul are finer and more subtle than any of the others. He also thought that, from every object in the outer world, atoms were being eternally thrown off, and that these atoms arranged themselves into tiny pictures of the object from which they had proceeded. These pictures, flying in all directions, bombarded everything that lay within their path, including, of course, eyes. Some of the pictures, entering the organ of sight by way of the pupil, were, inside the eye, perceived, or "seen," by the various intra-ocular "humors," or fluids.

These fluids, or intra-ocular humors, Democritus took to constitute the essential organ of vision—the sight-perceiving apparatus. They were, therefore, to him what the retina is to us.

It is said that Democritus, in order to become the more perfectly master of his intellectual faculties, put out his eyes by means of a burning-glass. The story, however, is not generally credited.—(T. H. S.)

Demodex folliculorum. A genus typical of *Demodicedæ.* An acaridan of this genus; an itch-insect. The most important relation of the demodex is its invasion of the sebaceous glands of the lids. Raehlmann has applied the term *blepharitis acaria* to those cases in which this parasite has been found. The etiologic importance of the demodex is doubted by Sulzer, who found it in the normal lids of one person out of six examined.



Demodex or Acarus folliculorum hominis. (After Perls.)

The disease of the skin of the eyelids caused in man by the invasion of the *demodex folliculorum* has also been studied by Herzog (Graefe's *Arch. f. Ophth.*, Vol. 69, p. 492, 1909). He finds that the mites fill the hair follicles and give rise to perifolliculitis, causing a falling of the lashes and finer hairs. The anatomic changes closely resemble those of trachoma, in which also there is distortion and loss of lashes. These tissue alterations extend in time through the whole thickness of the lids, and in the interspaces of the orbicular muscle.

Demonstrating ophthalmoscope. See **Demonstration ophthalmoscope.**

Demonstration ophthalmoscope. An instrument that will make it possible for two or more observers to conduct a simultaneous examination of the fundus oculi, either for diagnostic or teaching purposes, is rather an old device. One of the earliest demonstration ophthalmoscopes was invented by deWecker, in 1870. This was followed by later instruments, devised by Sichel and Burke. These devices were, however, of little value, inasmuch as the fundus image was not well defined. On the other hand, Thorner's ophthalmoscope that shows a well-defined image, no corneal reflex and a large field of vision (up to 37°) is of real value, and can be used to advantage in clinics and in the teaching of medical students. A simple demonstration ophthalmoscope, to be used for the inverted image by two observers working simultaneously, is described by Wessely (*Archiv f. Augenheilk.*, Vol. 71, No. 3). See, also, **Thorner's demonstration ophthalmoscope.**

Demonstrations, methods and appliances in the teaching of ophthalmology. See **Teaching methods in ophthalmology.**

Demosthenes Philalethes. The most important oculist in the world about the middle of the first century A. D., now scarcely known at

all. He seems to have lived and practised at Marseilles, and to have flourished especially in the reign of Nero. His work on ocular diseases stood as the highest authority for more than a thousand years, but is now lost completely.—(T. H. S.)

Demours, Antoine-Pierre. A famous French ophthalmologist, of the late 18th and early 19th century, son of the equally celebrated ophthalmologist, Pierre Demours. Born Dec. 16, 1762, Antoine-Pierre studied medicine in general and ophthalmology in particular with his father from the time of his earliest recollection. Not so great an investigator as his father, he was, nevertheless, unlike his parent, a bold and skilful operator. In fact, his daring (and, one might wellnigh add, his success) knew but little bounds. His services were sought by patients from every land. He became ophthalmologist to Ludwig XVIII and to Karl X of Bavaria.

Among his writings are the following:

1. *Mémoire sur sa Manière d'opérer la Cataracte. Lu à l'Assemblée, dite Prima Mensis*, le 1, Nov., 1784, Paris.

2. *Ophtalmostat de Demours fils.* (*Jour. de Méd., Chir., Pharm.*, 1785, tome lxiii, p. 230, and *Commentaires de la Faculté de Méd. de Paris*, 1777-1786, Paris, 1903, p. 1231.)

3. *Observations sur une Pupille Artificielle, Ouverte tout auprés de la Sclérotique*, Paris, 1800.

4. *Traité des Maladies des Yeux, avec des Planches Colorées Représentantes ces Maladies d'apres Nature, suivi de la Description de l'Oeil Humain, Traduit du Latin de S. T. Soemmering, par A. P. Demours, Médecine Oculiste du Roi.* (4 vols., Paris, 1818.) The plates are very beautiful, and, for the most part, true to nature. They were the best, undoubtedly, that had appeared at the time of their publication.

In this work are included hundreds of interesting and instructive case-histories, drawn from the practice both of himself (20 years) and of his father (a full half century).

5. *Précis Théorique et Pratique sur les Maladies des Yeux* (Paris, 1821).

Demours *fils* had the honor of introducing into France mydriasis as a preliminary step in certain ophthalmic operations, *e. g.*, cataract. It is likely that the practice itself was the invention of Himly.

Demours died Oct. 4, 1836, from grief over the death of his son, who was drowned in the Seine. He was a very noble and affectionate man.—(T. H. S.)

Demours' membrane. Another name for Descemet's membrane.

Demours, Pierre. A famous 18th century French ophthalmologist, father of the equally celebrated Antoine-Pierre. Born in 1702, at Marseilles, France, where his father was an apothecary, he studied medicine at Paris and Avignon, receiving his degree at the latter institution in 1728. Settling in Paris, he was soon appointed Demonstrator of the Collection of Natural History in the Royal Garden. Two years later, at the solicitation of Antoine Petit, he turned his attention to ophthalmology. In this branch he was very successful indeed as therapeutist and original investigator, translator and original writer, but not as surgeon. A great timidity seemed ever to bar him utterly from the use of points and edges; ball-terminated probes, however, and spatulas he employed without fear.

Demours' discoveries in the field of ocular anatomy have rendered him immortal. These discoveries related especially to the choroid, the cornea, the vitreous and aqueous humors. He described the corneal basal membrane, and, as many believe, for the first time in history. Priority in this discovery, however, he had to dispute with Descemet, who, it would seem, defeated him. At all events, "la lame cartilagineuse de la cornée," as Demours called the structure, was entitled by other writers of the time, at first, "Demours' membrane," later, however, the "membrane of Descemet." Today it is still known by the latter expression.

Among the writings of Demours are:

1. *Sur la Structure Cellulaire du Corps Vitré.* In "*Histoire de l'Acad. R. des Sciences,*" Année 1741, p. 60.

2. *Observations sur la Cornée. Loc. cit.*

3. *Dissert. sur la mécanique des Mouvements de la Prunelle. In Mém. de l'Ac. des Sciences,* 1750, p. 586.

4. *Lettre à M. Petit en Reponse à sa Critique d'un Rapport sur une Maladie de l'oeil Survenue après l'inoculation de la Petite Vérole.* (Paris, 1767.)

5. *Nouvelles Reflexions sur la Lame Cartilagineuse de la Cornée.* (Paris, 1770.)

6. *Réflexions sur une Maladie des Yeux où l'on Indique les Véritables. Causes des Accidens qui Surviennent à l'Opération bien faite de la Cataracte par Extraction et où l'on Propose un Moyen pour y Remédier.* (*Jour. de Médecine,* xvi, Jan., 1762, pp. 49-60.)

Demours practised as an oculist for 50 years. He became physician to the King, and Fellow of the Academy of Sciences. He died June 26, 1795, leaving his work to be continued by his son, Antoine-Pierre. —(T. H. S.)

Dendriform ulcer. See **Cornea, Dendriform ulcer of the.**

Dendrites. These are protoplasmic processes of the ganglion cell layer of the retina. They are directed outward and terminate in multiple short processes in the external plexiform layer.

Dengue, Ocular symptoms of. See **Dandy fever.**

Dennett's method. Wm. S. Dennett suggests the numbering of prisms by use of the *radian* (q. v.), an arc of a circle whose length equals the radius of its curvature. This arc equals 57.295°, and a prism that produces an angular deviation of the hundredth portion of this arc he calls a *centrad.*

Density, Optical. This is the quality inherent in media of retarding the rate of transmission of light, in conformity with a law uniting the index of refraction of a light-wave and its length.

Dent. (F.) Tooth.

Dental amblyopia. *Odontology and ophthalmology.* It has long been known that dental diseases, suppurative processes in particular, are productive of ocular symptoms. It is proposed here to refer definitely to a number of reports of such cases.

One of the most serious and best authenticated diseases of the eye occurring in patients suffering from dental disease is *optic neuritis.* This sequel usually follows antral disease and is secondary, in most instances, to the consequent orbital periostitis or cellulitis following infected teeth.

Two cases of severe corneal inflammation, apparently dependent upon complicated dentition, are reported by Bonsignorio (*La Clin. Opht.*, April 25, 1908). Higgs (*Jour. Ophth. and Oto-Laryngol.*, April, 1908) has also reported a case where, after the removal of a wisdom tooth, infection of the wound and abscess, that was opened repeatedly through the mouth and cheek, occurred. After this, opacity of the posterior lens capsule was discovered, reducing vision to 1/5, although the eye had previously been known to possess full vision.

A. G. Brinton (*Transvaal Med. Jour.*, July, 1908; *Oph. Review*, Oct., 1909, p. 306) instances two cases of corneal ulcer, which, after the removal of old stumps in the mouth, although there had been no toothache, healed with great rapidity, but which had previously resisted the most active treatment. In his opinion the corneal ulcers were due to the trophic influence of the fifth nerve irritated through the presence of the decayed stumps; but more likely to septic absorption. The writer appeals for the careful investigation of all the branches of the fifth nerve in cases of obstinate headache before resorting to operative interference with the nerve itself.

Gutman (*Ophthal. Review*, May, 1912, p. 160) describes orbital affections after tooth extraction. The cases are, briefly, as follows: A boy of 12, who, a week after the extraction of a right upper molar,

had a rise of temperature (104°). He had bilateral exophthalmos and a great deal of reddish, inflammatory edema of the upper lid. In the palpebral and ocular conjunctiva there was brawny edema rather than inflammatory injection. The globe was almost immobile, but the fundus was all but normal, only a slight engorgement of the veins being noticeable. Transillumination showed darkness over the right frontal sinus; on opening the sinus pus was found; while the ethmoidal cells did not contain any when they were exposed: the orbit itself was not directly interfered with. On lumbar puncture only clear fluid was obtained, but the case went on to a fatal termination with rigidity of the head and high septic fever. On examination post mortem pus was found in both orbits, rushing out when the roof was opened: on both sides the cavernous sinus was lined with purulent thrombi: purulent pachymeningitis, particularly over the sphenoid: the pia and the ventricles were not purulent. Further, there were abscesses of the lung, pleuritic effusion, and indications of a general septic infection. The microscopic appearances of the orbital tissues and the globes corresponded in general terms with the naked eye changes described.

Evidently, then, a septic process had begun in the alveolus, whether initiated by the use of a septic instrument or by infection subsequent to the operation; this had spread along the lymph paths to the right frontal sinus and orbit, thence by septic thrombosis to the cavernous sinus and to the left orbit: meningitis and death had followed.

In the second case a woman of 40 underwent extraction of a left upper incisor, and then four days afterwards developed left exophthalmos, with febrile symptoms. There was congestion of the veins of the conjunctiva and lids, and a similar appearance in the fundus. An incision was made along the roof of the orbit into the cellular tissue: no pus was obtained, the tissue was much engorged with blood. In spite of this incision, which was kept open, the temperature continued to rise and the exophthalmos to increase, but a fresh incision along the floor of the orbit let out a trace of pus. In four days the patient died of thrombosis of the left cavernous sinus.

The third case was that of a man of 27 who, three or four days after extraction of an upper molar, found his right cheek and lower eyelid to be swollen, and very shortly thereafter vision became affected. His antrum was opened at the canine fossa; but his fundus exhibited a white disc indicative of postneuritic atrophy, with shrivelled arteries. Vision was reduced to light perception. In this case the infection had traveled via the antrum and had affected the optic nerves more directly than in the two previous cases.

De Obarrio (*Anales de Oftalmologia,* July, 1912; abstract in *Annals of Ophthal.,* Jan., 1913) calls attention to certain disturbances of vasodilator origin and obstinate in character, which appear immediately after cataract extraction. The symptoms continue for an indefinite period. Pain is usually lacking. The condition occurs where the operation has been quite uncomplicated, and where in consequence the bandage has not been removed until the third day. The corneal wound appears normal and the patient is comfortable, but there is an alarming redness of the conjunctiva. Treatment lasting several days is often without result. The writer has had a series of six such cases, which he describes, in which, after looking in vain for an explanation of the eye condition in the ear, nose, throat, or other parts of the body, the fault was found to lie with diseased teeth. The offending teeth were in each case bicuspids or molars on the same side as the eye which had been operated upon; and removal of the carious teeth or roots was in each case followed by speedy recovery from the conjunctival disturbance. The action of these teeth is probably by way of the nervous system through the Gasserian ganglion.

A very obstinate unilateral follicular conjunctivitis was observed by Prestley (*N. Y. Med. Jour.*, May 4, 1912, p. 965) in connection with a severe pyorrhea alveolaris. Local treatment was of no avail and the disease persisted until the alveolar condition was cured, when the conjunctival symptoms disappeared. In ascribing various forms of asthenopia to mild auto-intoxication of intestinal origin, or better, enterogenous intoxication, Shoemaker (*Am. Jour. Ophth.*, Vol. 28, p. 134, 1911) mentioned several cases of mild chronic conjunctivitis with the same etiology. Relief from the conjunctival irritation was had only after general systemic treatment. Two forms of conjunctivitis without any definite etiologic factors are reported: one by Calhoun (*Am. Jour. Ophth.*, Vol. 28, p. 5, 1911) of a membranous type without any bacteriologic findings and with a negative tuberculin reaction, which disappeared completely under simple treatment; and one by Reid (*Brit. Med. Jour.*, May 4, 1912, p. 1008) of an epidemically appearing conjunctivitis with edema of the lids and conjunctiva and slight photophobia, combined with a very small amount of secretion, which during the first stages of the disease contained a few pneumococci.

Kalt (*Clin. Opht.*, Vol. 18, p. 160, 1911) reported a peculiar non-inflammatory disease of the conjunctival sac which resulted in a bilateral obliteration by the formation of strands of vascularized epithelium of great density. The ultimate outcome was the complete

obliteration of the sacs. No definite etiologic factors could be found, although syphilis was suspected to be the cause, notwithstanding a negative Wassermann.—(*Oph. Year-Book*, 1912.)

Jampolsky (*Wochenschr. f. Ther. und Hyg. des Auges*, Dec. 12, 1912) describes a metastatic ophthalmia following the extraction of a tooth. Five days after extraction of a lower molar in an eleven-year-old girl, a grayish-yellow reflex was observed in the pupil of the eye on the same side, this condition being preceded by fever and vomiting of two days' duration. On the sixth day herpes of the lip, catarrhal angina and suppurative iritis (with hypopyon); no socket infection. In spite of treatment, phthisis bulbi resulted. Pyemia followed by embolic metastasis to the choroid or retina, the writer considers as the etiologic explanation.

W. E. Bruner (*Annals of Ophthalmology*, Oct., 1912) considers both the functional disturbances and the organic changes in the eye from dental diseases. The former may be produced by an abscess or disease about the root of a tooth, or by an impacted tooth. These reflex effects will be produced more frequently when the teeth of the upper jaw are at fault. It may show itself in disturbance of the pupil or the motility of the iris of that side, in restriction of the range, or complete paralysis of accommodation, spasm of the orbicularis, in disturbance of the muscle balance, in asthenopia or in amblyopia, more or less marked, with negative ophthalmoscopic findings, entirely relieved upon removal of the cause of irritation.

The author had seen a small child who manifested a squint with the eruption of her teeth which disappeared when the tooth was through the gums. He has also seen cases of asthenopia in children who were having their teeth straightened, all the symptoms disappearing when the braces and all pressure have been removed. Blindness of functional type has been reported after extraction of a tooth.

Organic or structural changes in or about the eye resulting from the teeth may take many varied forms, and cases are on record illustrating inflammation of almost every structure of the eye dependent upon or at least attributed to dental trouble. Abscess of the orbit is well recognized as sometimes coming from an abscess about the root of a tooth. The author quotes cases illustrating ocular inflammations, such as iritis, episcleritis, corneal ulcers, and intractable keratitis due to tooth trouble. The mouth should always be examined for pyorrhea alveolaris before undertaking any operation on the globe. He states that Priestley Smith has reported a case of glaucoma due to irritation from the teeth; and Sterling has reported a case of a child developing

blindness due to optic atrophy following severe hemorrhage after the extraction of a tooth.

In conclusion the author points out that in those cases of irritation and inflammation of the eyes the patient is often unconscious of anything wrong with the teeth and will state that they have them examined regularly by a dentist. He strongly advocates X-ray examinations when defects in the teeth or dentistry can be detected.

Polet (*Ophthalmology*, April, 1913) believes that irritation and infection occurring in the gums, teeth and mouth may provoke ocular troubles, which may follow the course of the venous, osseous, subperiosteal and nervous channels. During the course of the first and second dentition kerato-conjunctivitis, lachrymation and the spasmodic contraction of the facial muscles are frequently observed. These same symptoms are most frequent during the eruption of the wisdom teeth.

The following conditions have been observed during the course of dental caries: Reflex amblyopia with peripheral contraction of the visual fields, mydriasis, myosis, disturbances of the accommodation, orbital neuralgia, paralysis of the oculi motors, blepharospasm, inflammatory lesions of the cornea, iris and choroid and hypertension. Abscess of the orbit and sinuses, emboli, abscess of the frontal lobe with atrophy of the optic nerves have all been observed during the course of periostitis.

Goulden (*Ophthalmoscope*, Vol. 9, p. 177, 1911) holds that oral sepsis is responsible for an important group of cases of iridocyclitis of generally unrecognized causation and for the more general symptoms of septicemia with which the ocular lesions are often associated. Among twenty-one cases of iridocyclitis he found four were of syphilitic and one of sympathetic origin; while in sixteen the etiology remained obscure. In one case a focus of septic absorption was found in the tonsils. The patient improved rapidly when this received attention; although a year's treatment previously had caused no improvement. In thirteen cases sepsis in connection with the teeth was present. When this was treated improvement was so marked in many instances as to leave little doubt of the connection between the oral sepsis and the iridocyclitis.

Two cases are given in detail. A man of 31 had been incapacitated for work sixteen months by effusion in the knee joint. This was diagnosed eight months later as a septic arthritis, from septic teeth. These were removed, as was supposed, and artificial teeth fitted. He came with severe iridocyclitis of the right eye; and the knee still somewhat swollen. For three weeks under treatment there was no

improvement. Then the patient called attention to a point of tenderness in the right upper jaw. A septic root was found and removed. After this eye and knee both rapidly improved, and the man remained quite well nine months afterward. A man of 29 had suffered from iridocyclitis for two years in the right eye and eighteen months in the left. He had been under the usual treatment without benefit. His teeth were in very bad condition, and he was advised to see a dental surgeon. The septic teeth were removed, and eighteen days later his eyes had greatly improved. They became and remained quiet. Out of eight cases of choroiditis no cause could be found for two except septic teeth. A case of panophthalmitis with general streptococcus infection, and death, following the extraction of two teeth is also reported by Goulden.

Terson (*Clin. Opht.*, Vol. 17, p. 547, 1911) reviews the anatomic relations of the mouth and teeth to the orbit emphasizing the proximity of the maxillary antrum to the lachrymal canal; and the occurrence of orbital abscess as the most serious complication. He gives a case of corneal ulceration, relieved by extraction of a diseased tooth, as an instance of a reflex through the fifth nerve.

Lelongt (*Rec. d'Opht.*, Vol. 33, p. 285, 1911) discusses three possible paths of extension of suppuration from the teeth to the orbit; (1) by channels through the bone; (2) by subperiosteal extension; and (3) by way of the lymphatics. The nasal end of the lower lid is especially liable to be the seat of abscess of dental origin.

Bruner (*Ann. of Ophth.*, Vol. 21, p. 744, 1911), in addition to the observations just quoted, saw headaches, dizziness and blurred vision relieved by removing the roots of the upper incisors. He also saw a case of orbital abscess and thrombosis of the cavernous sinus following abscess at the root of a tooth; and in another patient iritis that seemed to arise from pyorrhea alveolaris. He attaches great importance to the X-ray examination, and points out that treatment of the teeth, if not carried out by a competent dentist, may not remove the cause of ocular symptoms.

Wm. Lang (London *Lancet*, May 17, 1913; *Ophthalmology*, October, 1913, p. 120) has examined and reported upon all cases of inflammatory affections where the ordinarily accepted causes of the disease were absent. The writer came to recognize that pyorrhea causes inflammation in every part of the eye. In cases in which the mouth was clean he began to look elsewhere for sepsis and realized that the source of sepsis might be in any of the mucous membranes, in a chronic sore on the skin, or in a sinus opening on the skin or on a mucous surface. Although he failed to discover the nature of the

poison, he became convinced that the diagnosis was correct, because, as soon as the source of sepsis was removed the inflammation began to subside, the rheumatic pains in various parts ceased, a feeling of well-being took place, and in recent cases of central choroiditis the lost vision quickly returned.

In order to ascertain what proportion of cases of inflammation of the eyeball was due to sepsis he had a table made from the notes of his last 10,000 patients where a cause had been found, including all except those limited to the conjunctiva. This shows the source and number of the cases (215) attributed to sepsis:

Lachrymal sac	1	Large gut infection, including colitis and the like	33
Antrum of Highmore	1	Kidney and the bladder	4
Nasal inflammation	2	Male urethra	20
Inflamed tonsils	3	Uterus and appendages	3
Pyorrhea	139	Skin diseases	4
"Indigestion"	2		
Appendicitis	3		

Though it would appear to be obvious from this table that sepsis from pyorrhea is an important agent in causing inflammation of the eye, nevertheless the general application of this view is not universally accepted.

The usual objection made is that one sees very bad cases of pyorrhea in people who say that they are enjoying the best of health and who do not complain. These objectors seem to forget that Nature begins to raise a protecting barrier the very moment that the tissues are irritated by bacterial toxins or are invaded by the bacteria themselves. If the invasion is slow enough, as is the case in pyorrhea, the barrier is efficient and the individual does not appear to suffer. Whereas when the micro-organisms are introduced direct into the circulation there is no time for an efficient barrier to be raised. As long as the patient is in fair health the barrier is capable of doing its work; but this barrier may give way directly the general resistance of the tissues is lowered under the strain produced by some illness or by traumatism, either surgical or accidental. Then the organisms or an excess of their toxins will be able to pass through the defending barrier and some tissue in the body may become the seat of the disease. The enormous number of cases of pyorrhea that one sees and the comparatively small number of diseases resulting therefrom shows how very efficient nature's barrier is.

The writer also draws especial attention to the baneful influence that a chronic septic focus frequently exerts upon eyes that have been operated upon. The eye often becomes acutely inflamed, and remains

red for a much longer period than the severity of the operation would warrant, but rapidly quiets down when the exciting cause has been removed. Although no permanent harm usually results, such a complication to the operation as this is to be avoided if possible, and therefore before he operates on any patient he always has the mouth examined and put in order if necessary, and has a search made for any other septic foci, should there be any indication for so doing. (Abstract by C. H. May in *Ophthalmology*, Oct., 1913.)

In Würdemann's case (*Ophth. Record*, Vol. 22, p. 652, 1912) of severe pain behind one eye, of a year's duration, the cause was apparently the presence of a dental spud which extruded from the root of a filled and crowned tooth.

Finally, L. Dor (*La Clin. Ophtal.*, April, 1911, p. 176) describes hysterical amblyopia of dental origin.

Dentiform ulcer. A name for the "indented" or tooth-like form of superficial corneal ulcer occurring mostly in adult subjects, generally beginning at the scleral margin, and called by Fuchs *keratitis marginalis superficialis.*

Dentists, Asthenopia among. CONSERVATION OF THE EYES OF DENTISTS. This subject may with propriety be briefly discussed here. The Editor, in an address (*Dental Review*, Dec., 1906), has stated the matter as follows: "First of all, I should like to speak of the student of dentistry. Like other students or, perhaps, more than other students, it is necessary that he should do near work all day long. When he is not reading text-books or writing lecture notes, or doing microscopical or bacteriological work, he is examining minutely the mouth and teeth of patients. Consequently the fact that strikes me as important in the case of a dental student is that he should begin his college work with a good pair of eyes. If he is far-sighted or astigmatic or has any other defect that can be cured or relieved, attention should be given to his eyes early in his studies. If he has an incurable disease of the eye, or has a defect that makes it impossible to use his eyes for long periods, then I would strongly advise him to abandon or never attempt the study of dentistry. I not infrequently have as a patient a dental student complaining of headaches or pains in the eyes or defective vision, because of an undetected error of refraction or an eye-muscle defect that has not been remedied. Still more unfortunate is it to be consulted by a dental student who has had a complete breakdown in attempting to use his diseased or defective eyes for continuous near work. A short time ago I examined a second year student who, while he had normal vision with one eye, had very defective sight in the other. In the weaker eye there was a

congenital condition which made it impossible for him to have binocular vision. He complained after working, either with a patient in the dental chair or reading much at night time, that his head commenced to ache and that objects in front of him became blurred or indistinct. I advised him very positively not to persevere in his studies, or at least to undertake some department of practice that would not involve the continuous use of his eyes for near work.

"Let me repeat that before the dental student is allowed to undertake the arduous curriculum (as a preliminary to still more exacting use of his eyes) that he should have his whole ocular apparatus carefully examined.

"Let us consider now the dentist, after he has received his diploma and settles down for the practice of his profession. Assuming that his eyes are in the best condition possible for the work which he will find it necessary to do, I regard the illumination by the aid of which he expects to do his work probably the most important consideration. It may be stated at the outset that natural light of the diffused variety, that is, not direct sunlight, is the best form of illumination for the dentist's work. When there is any choice in the matter artificial light should never be employed for the difficult work that the dentist's eyes are called upon to do. Should it be necessary to use artificial light, the modified electric light, or, better still, gas, is preferable. Of course, these considerations will not be appreciated by men with good, strong eye muscles, normal eyes (eyeballs that are neither too far-sighted or astigmatic), a stable nervous system and a good digestive apparatus, or who are under forty years of age. As soon as any of these factors are lacking then will the dentist know what is meant by a poor illumination. The old rule laid down by Magnus obtains with peculiar force in the practice of dentistry, namely, that in all near work especially the illumination should neither be too strong nor too weak; it should imitate as nearly as possible diffused sunlight, and it should always shine upon the work to be done and never, either directly or by reflection, into the eyes of the operator. I have noticed in a number of dental offices that a strong light is thrown into the mouth of the patient as well as into the eyes of the dentist. This is one of the worst mistakes that can possibly be made by any man doing continuous close work. While it is quite proper to have an effective light falling upon one's work, the eyes of the operator should be in comparative darkness. If the near-worker is to preserve his eyesight until old age he should not abuse his eyes by neglecting this rule. There is no question but that, especially after 40 years of age, the man who misuses his eyes in this way is more liable to cat-

aract, disease of the choroid and retina and to a sort of dulling of sight due to degeneration of the optic fibres.

"The use of glasses is an important matter to the dentist. We often hear a man boast of his good distant vision. Time and time again one listens to people telling of their capacity to see a church clock three miles away when other people are unable to distinguish its outlines. These as a rule are people who are far-sighted, i. e., those who at, say, 25 years of age, possess unusually good vision for the distance. It so happens, however, that it is the worst possible kind of sight that a man can have if he is obliged all day long to do near work. The fact is that a slight degree of near-sightedness (myopia) is much preferable than any form of far-sightedness. The dentist's work lies within a range of a metre or two; he is rarely interested in anything more than twenty feet away, and his vision should be adapted to these conditions. If, therefore, he has an appreciable amount of far-sightedness it ought to be neutralized by means of appropriate glasses. The same thing is true of astigmatism (a deviation from the normal shape of the eyeball) and is particularly true of astigmatism combined with hypermetropia or other curable defect. These glasses, in the majority of cases, might be called 'operating' glasses, and inasmuch as they enable the eye to see close at hand with the least amount of strain, might in the majority of cases, be used only while work is being done.

"In this connection there is an old superstition that if you put on glasses early you will not be able to do without them and that something dreadful will happen in consequence of this 'slavery to habit.' There never was a more mistaken idea, because no man by merely 'taking thought' can really cure a defect due to an abnormal shape or a deviation from the normal shape and size of the eyeball. The early use of glasses is of much use to the far-sighted individual who persists in using his eyes much for near work.

"There is another well recognized rule that will enable most people to decide whether they need glasses for their near work. When an individual finds that he can not, at ten inches in front of him read, in a dim light, 'diamond' print with each eye separately, he ought to have glasses to assist him in his work. Nothing is to be gained by waiting, because the eye is being strained in the meantime. Of course, if one will give up near work and live an outdoor life for nine months out of the year, glasses of this description are not necessary and would be entirely superfluous, but when the dentist, the oculist, bookkeeper, stenographer, *et hoc genus omne,* persist in work-

ing all day long for eleven months out of the year, special arrangements are generally necessary for such abuse of the eye.

"The man who persists in using his eyes for the great majority of the working hours at close range, can not afford to further abuse them by reading badly printed newspapers with a poor light, or to read on railway trains and street cars (as most of us do) or do much reading while lying down. I do not say that reading for half an hour in a prone position makes any great difference with the average individual, but this habit indulged in for several hours at a time increases the congestion of the interior of the eye, and sooner or later produces changes in the eye itself.

"Finally, one of the exciting causes of eye-strain, especially in students, is too long hours and lack of recreation. I mean lack of that particular form of recreation that gives the eye a rest. From an ocular standpoint it is a great mistake to work in a down-town office all day and then take recreation by going home to read a book or magazine. Far better to emulate the example of your chairman by an excursion into the woods or by taking a fishing excursion, or, in winter, going for long walks. Choose one of these forms of recreation as an investment. Do it because you feel that you owe it to your eyes. You use your eyes more in doing your daily work than you do any other organ of the body. Possibly we are all obliged to do a great deal of talking, but the tongue does not suffer from tongue-strain as the eyes do from eye-strain. If you will give your eyes a chance to recuperate you will subsequently do better work, and, possibly, just as much work as if you had tired them out in the operating chair for a few hours longer. You ought then to neutralize any possible damage to your eyes by taking pleasurable excursions. Such a course will calm your tired nervous system, act as a tonic to your muscles, increase your digestive power and thus indirectly furnish you with more competent eyesight.

"I need hardly suggest to gentlemen in your profession that the moment any eye symptom or eye defect is noted you should at once repair to the oculist for counsel. Nobody knows better than the dentist how people neglect their teeth but, on the other hand, it is possible to be fitted with artificial organs of that variety. We may purchase new teeth, but we can not purchase new eyes. A short time ago there came to me a dentist from a neighboring town who had a very good practice, and whose history was one of defiance of every law of health, general and ocular. He began his college life with poor eyes and suffered from eye-strain, headaches, inflammatory signs of ocular disease, and so on. Now, at an early age, he has

developed cataract in both eyes (as the result of chronic choroiditis) due to nothing more or less than a downright abuse of his eyes and nervous system. He at first thought the choroidal disease was a temporary, unimportant trouble and did nothing for it. I am sure that the disease itself and the consequent cataract might have been prevented, and that he might still be pursuing his hitherto successful career, if he had paid ordinary attention to his general health and to the condition of his eyes.''

Deontology, Medical. Medical ethics; the duties of physician to his patient, to his fellow practitioner and to the public at large. See **Ethics, Medical.**

Deorsumduction. A downward movement, as of the eye.

Dépense. (F.) Expenditure, as of strength.

Depigmentation. Removal of pigment. For example, Oatman (*Arch. of Ophth.*, Vol. 39, p. 392, 1910) reported a case that showed almost complete depigmentation of the fundus with disappearance of the chorio-capillaris and many of the medium-sized vessels. The pigment from the retinal epithelium had also disappeared.

Axenfeld (*Bull. de la Soc. Belge d'Opht.*, No. 29, p. 115, 1910) describes certain senile degenerative changes in the iris that diminish dilatation of the pupil. They include hyaline and fibroid changes and depigmentation which may affect the pupillary margin, at first making it appear interrupted, and later leaving a white or grayish semi-transparent border to the pupil. The loss of pigment may also involve the uveal pigment layer, or the anterior pigment tissue of the iris, causing marked alterations in appearance. Lauber (*Zeitschr. f. Augenheilk.*, Vol. 24, p. 82, 1910) has reported a case in which the disappearance of pigment of the pupillary margin caused the pupil to appear larger, while the degenerative change prevented any dilatation by mydriatic.

Deplanate. Flattened or made level.

Deplumation. Shedding of the eyelashes.

Depolarization. The act of destroying the effects of polarization.

Depolarize. To change the direction of polarization of a polarized ray.

Depolarizer. An apparatus consisting of a plate formed from the section of the principal plane of a double refracting prism which, when interposed at any angle between the polarizing surface and the analyzer, refracts and resolves the polarized ray into ordinary and extraordinary rays which attain the analyzer in planes that are neither parallel nor perpendicular to its principal plane, and are therefore

again refracted, the sum of the images of like name forming separate images which are individually transmitted.—(Foster.)

Depolish. To dull, or remove the glaze, from a surface.

Deposito di calce nelle cicatrici corneali. (It.) Deposit of chalk on a corneal scar.

Dépôt. (F.) Deposit. Sediment.

Depressio cataractæ. (L.) The operation of couching, sinking, or depressing the lens (with its capsule) into the vitreous by pressing with a needle from above directly downward. It is the oldest operation for getting rid of an opaque lens, and was employed in the most remote times. See **Couching of cataract.**

Depressio cataractæ per scleroticam. (L.) Depression, couching or reclination of the lens by a needle introduced through the sclera.

Depression of cataract. A synonym of **Couching of cataract.**

Depressor oculi. (L.) The rectus inferior oculi muscle.

Depressor palpebræ inferioris. An anomalous bundle of fibres of the platysma myoides inserted into the lower eyelid. They were originally supposed by Heister to constitute a distinct muscle, which he described as a fleshy bundle forming part of the orbicularis palpebrarum.

Depressor supercilii. (L.) A bundle of muscular fibres which occasionally extends from the ligamentum palpebrale medium to the skin of the upper eyelid.

Deprimens oculi. (L.) A name for the rectus inferior muscle.

Deprimirender Augenmuskel. (G.) The inferior rectus muscle of the eye.

Depth, Estimation of. SENSE OF DEPTH. STEREOSCOPIC VISION. Perception of depth. This may be defined as the ability of the eye to distinguish between the relative position of objects. The law of identical points was supposed to be absolute up to the time that Wheatstone constructed his stereoscope. This shows that the perception of depth is caused by a slight non-identity of the two retinal images. An object appears to us to be solid when each eye views it from a different point, as in normal vision. Thus, let the observer look at a house. One eye sees more of one side of the house than the other, and *vice versa*. Thus, each eye has its own picture of the house, and the simultaneous use of both eyes gives us a correct idea of the third dimension. It is the unlikeness of the two pictures which gives the idea of depth. The stereoscope is an instrument for viewing two similar pictures which are made to overlap, giving the appearance of solidity and depth. The stereoscopic field of vision, or region in

which the visual fields of the two eyes overlap, subtends an angle of about 90 degrees.—(J. M. B.)

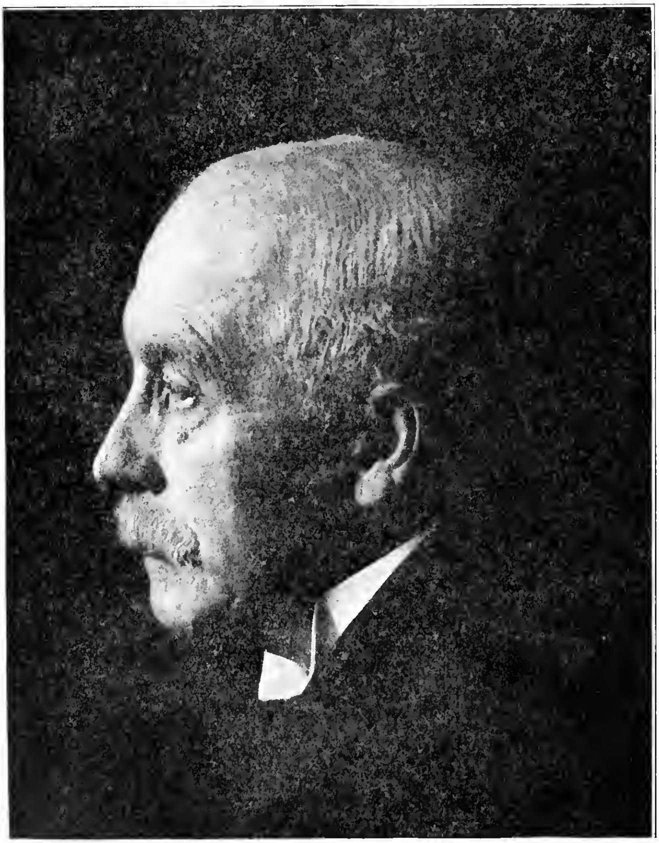
Wolff (*Zeitschr. f. Augenheilk.*, Vol. 25, p. 405, 1911) describes an apparatus for testing perception of depth.

Depth of definition. The property of a photographic lens of producing a sharp picture of objects situated at various distances from it.

Depth of focus. The power of a lens of giving a distinctly defined image of objects not in the same plane.

Derbe Augenhaut. (G.) External ocular covering.

Derby, Haskett. A celebrated ophthalmologist of Boston, Mass. Born



Haskett Derby.

in Boston, June 29, 1835, he received his training in the arts and sciences at the Boston Latin School and at Harvard College. He then studied medicine at Harvard, at the University of Vienna, and

at the Graefian Clinic. He received his medical degree in 1858, and began to practise ophthalmology in his native city about 1861, very soon acquiring an international reputation. He was a member of the Heidelberger Ophthalmologische Gesellschaft, and was one of the founders and once president of the American Ophthalmological Society. He served in a medical and surgical capacity during the War of the Rebellion, was for thirty years consulting surgeon to the Massachusetts Charitable Eye and Ear Infirmary, founded in 1887 the Eye Clinic in the Carney Hospital, at Boston, and for many years was lecturer on ophthalmology at the Harvard Medical School. A clever diagnostician, he was also a calm, deliberate and successful operator, and a clear and forceful writer. He was strict in his discipline with students and patients alike, but was even more exigent still in the demands which he made upon himself. His punctuality was a matter of common remark, and he was a tireless worker.

Though very undemonstrative, Dr. Derby was a man of kindly feeling and of great public spirit. He was ever busy in some great enterprise for the universal welfare. He was trustee of the Public Library and of the Children's Institutions Department at Boston.

Among his more important writings are the following:

1. Graefe's Clinical Lectures on Amblyopia and Amaurosis. (Eng. Trans. by Dr. Derby, 1866.)

2. Eine Analyse von 61 Staaroperationen. (*Boston Med. and S. J.*, 1871.)

3. The Importance of the Ophthalmoscope as an Aid to General Practice. (*Boston Med. and S. J.*, 1871.)

4. Die Behandlung der Kurzsichtigkeit mit Atropin. (New York, 1875.)

Dr. Derby died at his home in Falmouth Foreside, Maine, Aug. 21, 1914, aged 79.—(T. H. S.)

Derby, Richard Henry. A well known ophthalmologist of New York City. Born in 1844, he received at Harvard University the degree of A. B. in 1864 and that of M. D. in 1867. After a brief period as house surgeon in the Massachusetts General Hospital, he proceeded to Germany, where he studied ophthalmology for some years under von Graefe. For a considerable portion of this time, he acted as von Graefe's assistant.

Returning to America in 1870, he began to practise ophthalmology in New York City, and remained in this location until his death. He was a member of the New York Academy of Medicine and of the New York Ophthalmological Society, and a member of the American Ophthalmological Society since 1871. He was consulting oph-

thalmologist to the Orthopedic Hospital and the Trinity Hospital, and was one of the consulting physicians in the Hospital for Scarlet Fever and Diphtheria. He was also a trustee in the New York Institution for the Blind.

He was a very active man in other fields than that of ophthalmology. Thus, he was a member of the council of the Charity Organization Society, of the State Charities Aid Association, of the Committee of Twenty-One in 1881 (appointed for the purpose of reforming the street-cleaning system) and a member of the Committee of Seventy in 1894. He was also a vestryman in Trinity Church.

He was an excellent ophthalmologist, being both a shrewd diagnostician and a dexterous operator. He was pleasant, even genial, with all his patients, rich and poor without distinction, and was liked and esteemed by them all.

He died July 4, 1907.—(T. H. S.)

Derivative remedies in ocular diseases. COUNTER-IRRITANTS. Their action is supposed to influence, from a distance, organs that cannot be treated locally, especially those affected by hyperemia, congestion, irritation, inflammation or suppuration. Derivatives were much in vogue during the medical era of humoral pathology and (in general) have been abandoned in modern therapy with, perhaps, the exception of ophthalmology where—particularly in Germany—they are still in use. Renal derivatives, increasing secretion, are represented by diuretics, as, for instance, in uremic diseases affecting vision. Diseases of the choroid, especially those accompanied by opacity of the vitreous humor, and the malignant form of rapidly progressive myopia are beneficially influenced by certain irritating foot-baths. Such foot-baths should be applied as hot as possible and shortly before retiring. Into from two to four gallons of water are thrown ordinary powdered salt and mustard (2 to 3 handfuls of each), potassic bicarbonate (2 to 3 tablespoonfuls), or aqua regia (2 to 3 tablespoonfuls). Cupping about the temporal region is also often beneficial in acute hyperemia and inflammation of the choroid. The use of cantharides and mustard plasters has been almost abandoned in ophthalmic therapy.

Dermal diseases, Ocular relations of. Within recent years there have been reported with increasing frequency disease of the ocular structures associated with, or directly connected with, distinct disease of the skin. This association can hardly be regarded as merely coincidental; on the contrary, certain of the affections appear to be positive extensions of the dermal lesions into the ocular tissues, where they

undergo such modifications as would be occasioned by functional activities of the complex organ which they have invaded.

It is intended to describe under various headings such oculo-dermal diseases as have become of sufficient importance to merit the placing of them as distinct clinical entities. It has been thought well, however, to refer here to the association of the two classes of affections and to direct the reader to consult the captions as they appear in the alphabetical order of their arrangement.

It is too well known to require more than the mere statement, that the absence of pigment in the body-covering may be accompanied by absence of pigment in the uveal tissue, so that the albino is void of pigment in iris and choroid as well as in the skin and hair. Moreover, disturbances of sight dependent upon pigment absorption in the uvea have become manifest in progressive vitiligo.

Several years ago de Schweinitz, in a communication before the College of Physicians of Philadelphia, described a case which exhibited an apparent alternation of choroidal disease and acne in a subject of that affection: the ocular symptoms were less when the dermal process was greatest, and the choroids became more affected when the skin was smooth. The writer of this section has himself had under observation a young man of 26, a physician, whose history for the past twelve years has been practically a repetition of this. And another, in a clergyman, believing himself to be an easy victim of poison by ivy and other plants, whose hands, wrists and ankles are subject to attacks of a form of seborrhea, the symptoms of which are aggravated when he works in his garden, has had more or less clouded lenses for years, yet his lenses become clearer and the visual acuity higher when the dermal symptoms are at their height.

Without doubt the keratitis of acne rosacea is a true part of the rosaceal disease, as Holloway, Chance and others have pointed out.

Why erythema and pemphigoid diseases should extend to the conjunctiva is a subject somewhat difficult of explanation. It is, however, more than a mere hypothesis that the conjunctiva itself has been affected by the processes.

Many an ophthalmologist has noticed dermatitis of the lids, with irritability of the nasal mucous membrane, develop and become marked in astigmatics who have gone without glasses, or whose astigmia has been imperfectly treated, yet they have been relieved when perfect glasses have been adjusted and worn.

The connection existing between herpes zoster affecting the skin of the face and head and the succeeding invasions of the conjunctiva and cornea is certainly well marked, and its status deserves consideration in all treatises upon the two classifications of disease.

The dermal lesions so prominent in the acute contagious diseases may become a serious menace when they arise in the vicinity of the orbital structures. The eye does not escape the invasion of leprosy, and a study of the manifestations of syphilis of the iris will disclose characteristics comparable to the forms of the eruptions seen in the skin, from papules and vesicles to true necrosis.

The skin of the eyelids is subject to forms of disease of the skin likely to be found elsewhere; and the eyebrows and cilia may be affected by the same conditions found in the hair elsewhere; while the sebaceous glandular structures of the lids are not exempt from processes affecting the glands of the general surface of the body, while animal and vegetable parasitic organisms found on the skin and its appendages do not spare lids, lashes, glands, conjunctiva or cornea. —(B. C.)

Dermanyssus gallinæ. This common tick, parasitic on the domestic fowl, has been found once and described by Fischer as a parasite of the eye of a woman. Designated often as the chicken louse it is really a mite (acarid) rather than a hexapod. It goes over to man readily and is often met with as a skin parasite on those who frequent ill-kept, infected chicken houses. It induces a transient itch which is usually mild and may be entirely unnoticed. It is comparatively common in many parts of this country and as this record cited from Guiart shows may sometimes get into the eye.

The patient was a woman who had experienced a feeling of pain and inflammation in the eye. Fischer found that a foreign body in the form of a dark point was deeply implanted in the cornea. It was extracted together with a fragment of the cornea and on examination proved to be a "chicken louse" as he said. The description is somewhat inadequate but the form is apparently the well-known species, *Dermanyssus gallinæ*, to which this name is often applied. The animal had been thrown into the eye by a stroke of the wing from a bird that was sick and had been tended regularly by the patient.—(H. B. W.)

Dermataneurie. (F.) Cutaneous analgesia.

Dermatitis, Ocular relations of. DERMATITIS IN GENERAL. The term "dermatitis" is applied to a group of inflammations of the skin, the peculiarities of which arise not from the form and arrangement of the elementary dermal lesions, but from the reactions excited by thermal, chemical, electrical or mechanical agencies. Some of these causes exert their effects directly, such as those from the external application of heat and cold, and others indirectly, as when certain medicines have been taken internally. While, for the sake of con-

venience, this group of affections may be classed under the name of *dermatitis,* they have but little in common, except their general title. Some qualifying term, therefore, is added to point to their origin. Dermatologic writers have grouped the several varieties under such heads as dermatitis traumatica, dermatitis calorica, X-ray dermatitis, dermatitis venenata, dermatitis medicamentosa, dermatitis vaccinata, dermatitis gangrenosa, etc., each of which will be discussed in this section with its ocular symptoms, pathology and treatment.

The inflammatory processes may involve only the superficial or the deep portions of the integument, or they may extend to the subcutaneous and deeper tissues.

The *symptoms,* therefore, vary with the nature of the cause and the circumstances attending its operation, the extent and degree of its influence depending upon the susceptibility of the individual. The signs of inflammation, heat, redness and swelling, are in proportion to the severity of the lesion. Hence such dermatitis may be mild or severe, the milder forms disappearing without leaving behind persistent lesions, while the graver forms may be accompanied by serious systemic derangements and may terminate in gangrene. The predominant lesion, however, in the greater number of cases, is an erythema or hyperemia followed by fluid or plastic exudations in the manner of all the elementary dermal lesions, in the form of maculæ, vesicles, papules, bullæ, etc.

Dermatitis traumatica. Under this head are included all kinds of inflammation set up by mechanical causes, such as contusions, abrasions or excoriations, whether due to blows, friction, or scratching to relieve irritation, as of that excited by animal parasites. The symptoms differ according to the character and severity of the traumatism. Gangrene may follow after seemingly trivial injuries to the lids. It is likely in such cases that virulent microorganisms have entered through abrasions.

Dermatitis calorica. The extremes of heat and cold are almost equally capable of producing more or less severe inflammation of the skin, according to their intensity and the length of the time of their exposure to these extremes of temperature. *Erythema solare,* or sunburn, is a familiar example of what may be produced by the actinic rays of the sun (*dermatitis actinica*), which may be erythematous, vesicular or bullous, yet it never goes on to such complete destruction of the skin as may ensue from artificial or ordinary burns or scalds. Cold may produce death of the part from the prolonged anemia, or from the too sudden reaction attending its use and consequent destructive inflammation.

X-ray dermatitis. Exposure to the Roentgen rays, when unduly prolonged, or too frequently used at short intervals, especially when soft tubes are held too close, is likely to set up, in persons of unusual susceptibility, a dermatitis which usually reaches only to erythema, followed by pigmentation.

In the early days of the use of X-rays, cases of dermatitis came under the observation of the writer, in ladies, especially of the blonde type, who had sought relief from "facial blemishes" at the hands of "beauty doctors" who ignorantly had used strong currents too long, with the result that the lashes and brows fell out and the lids became swollen and puffed, and in certain instances vesication with consequent desquamation set in. Others have reported quite serious sloughs, resulting from undue exposure. Such effects were brought about through the devitalization of the tissues and degeneration from an interference with the process of reproduction of new cells. It is now known that the action of the rays is cumulative and that toxins are formed through cellular destruction which causes a secondary inflammatory reaction from degenerative changes in the blood vessels which may lead to ulceration and necrosis.

Dermatitis venenata. This group includes the various inflammations set up by numerous external irritations caused by caustic, irritant and toxic agents of animal, vegetable or mineral origin. The effects produced on the skin are marked by erythematous patches and swellings, small, closely-packed papules, vesicles, bullæ, scales or crusts and in some cases purulent discharges, abscesses and even gangrene, according to the susceptibility of the individual, the virulence, or concentration of the poison, and the length of exposure to its influence. Ordinarily the affections last for a few days only. Eczematous subjects are especially sensitive to such irritating influences, and in such persons eruptions are not only more easily started and more severe, but often persist long after the removal of the source, in the form of an eczema, indistinguishable from the ordinary essential eczemas.

Some persons are peculiarly susceptible to the irritant juices of poison-ivy and poison-oak (Rhus toxicodendron and Rhus venenata) and other plants, especially the primrose (Primula obconica). The outbreak of ivy-poisoning is characterized by burning and itching, which may be intense, and then the development of erythematous areas of a deep-red color and the eruption of closely-grouped vesicles and bullæ exuding a yellowish fluid which later dries and forms soft crusts. The lids are swollen and puffy and in severe cases the eyes

are completely closed. The poisoning by the primrose is characterized by itching and eruptions of eczematous or urticarial types.

Dermatitis medicamentosa. Drug eruptions. The ingestion or absorption of certain drugs may give rise to inflammation and in some cases the outbreak has been localized in the eyelids. The outbreak may occur after a minute dose of the drugs, as after the first instillation of a cycloplegic to which the individual is peculiarly susceptible. Other substances require the prolonged administration of larger doses, and others, as the bromides, may be only an expression of a cumulative action.

Numerous drugs are capable of producing a dermatitis; among others the following have been known to set up inflammation of the delicate skin of the eyelids:

Chrysarobin, when applied to the scalp, produces a coppery-red erythema which may extend to the forehead and eyes causing an outbreak resembling erysipelas and severe conjunctivitis. After a few days the redness and swelling subside and a purplish desquamation ensues.

Iodoform occasionally has caused a dermatitis which may extend over the lids and into the surrounding parts, producing even vesicular or bullous eczema. Dry powdered iodoform is likely to be more irritating than when the powder is rubbed up in the form of an ointment, yet I have seen extensive involvement following the use of salves which have been spread on compresses that were worn over night.

Mercury may cause dermatitis on and about the eyelids, when applied in the form of the strong bichloride antiseptic solutions, or mercurous, or calomel insufflations, and the oxides in ointment.

Hair dyes and *cosmetics*, especially those used on the brows and lashes, have frequently caused an intractable dermatitis.

Strong acids, alkalies and other caustics produce, as is well known, all degrees of inflammation up to the complete destruction of the tissues.

When *silver nitrate* is used over a long period there is always the possibility of its causing discoloration of the integument, as well as of the conjunctiva, and occasionally an erythematous eruption follows; and edema may persist for several days when strong solutions have been used in the treatment of conjunctivitis. And, as might be expected, solutions of *argyrol*, especially when they infiltrate the tissues, as when used in the lachrymal passages, usually cause a brownish stain; and they may excite a chronic inflammation of the skin of the lids.

The untoward effects of *cycloplegic drugs* are of particular interest to the ophthalmologist. It has long been known that belladonna and atropin produce scarlatinal eruptions, and it is well to keep this knowledge before us when it is necessary to prescribe such solutions for long-continued use. Substitutes for atropin, like duboisin and hyoscin, are more likely to set up a dermatitis than solutions of the more stable alkaloid. And the action of dionin in producing a temporary edema is now so well known as to call only for mention.

Erythema and cyanosis of the lids have been noted after the ingestion of *acetanelid* and other similar coal-tar products.

Chloral may excite a scarlatina-like redness, with fever and congestion of the conjunctiva. In severe cases there have been pustulation and ulceration with accompanying damage to the cornea.

Digitalis has been known to produce a scarlatiniform eruption, in severe cases resembling erysipelas.

Animal bacterial vaccines have excited erythematous and wheal-like rashes on the eyelids, and sometimes edema of the lids and conjunctiva. McKendrick has reported a case of a man who was particularly susceptible to the action of *pollantin* when that substance was instilled into the conjunctival sac.

It is difficult to account for these disturbances; without doubt, distinct idiosyncrasy is to be found in the individuals manifesting them. Women and children are more susceptible to the toxic effects of these drugs, and so are those of a nervous temperament and especially those who are in a weakened state, particularly those with cardio-renal disease and otherwise subject to defective elimination. It is likely that the effects are brought about through disturbance of the vasomotor centers and the peripheral nervous circulation. Yet as drug substances have been found in the tissues, it is conceivable that the substances themselves may excite the inflammation directly.

The *diagnosis* ought not to be difficult when there is the history of the use of drugs; and, while the eruptions usually resemble distinct dermal lesions, they do not have the true characteristics of such lesions. So, too, when they suggest the acute exanthemata the absence of constitutional symptoms is to be noted.

In most instances recovery soon follows the withdrawal of the drug, yet the prognosis should be guarded when an individual past middle life presents such symptoms, because they may indicate defective elimination and their presence should draw attention to the state of the cardio-renal system.

Other forms of dermatitis affecting the eyes. The *stings* of bees, wasps, hornets, and other stinging and biting insects may give rise

to alarming symptoms when the eyelids are involved. The *hairs of caterpillars* have been known to prick and become lodged in the skin, exciting an intractable dermatitis which has persisted until the broken hairs have been withdrawn.

Serious destruction of the skin may accompany the invasion of the hair follicles by micro-organisms. Herzog has described the effects of the presence of the *demodex folliculorum* which caused a perifolliculitis, and, later on, the loss of substance with distortion of the muscular substance.

Vaccinal and other distinct exanthematous eruptions may be localized in, or seriously affect the eyelids. Gangrene of the lids following chicken-pox has been recorded by several observers, and numerous instances of necrosis of the lids during convalescence from measles have been reported.

It is probable that gangrenous processes in the course of the exanthematous and febrile infectious diseases have been caused by the lodgment of a phlegmon in the circulation of the lids.

Edema may arise without any traceable cause, accompanied by fever, and, lasting for three or four days, subside, i. e., a fugitive edema. Instances have occurred where mild epidemics have been noted by several observers, so that these might be classed as truly infectious in origin. Certain other cases have been characterized by relapses. Here it may be that stasis in the lymphatic circulation of the nasal passages has obstructed that of the ocular structures.

Butler has reported a case of *recurrent dermatitis,* followed by desquamation, which resisted all forms of treatment until a pronounced hyperopia was corrected by appropriate spectacle lenses. Such a case as this, and others exhibiting transitory edema, may be classed with one reported by von Heuss, in which there was swelling of the lids with brownish discoloration and scabbing. In this case the attacks recurred nine times in seventeen months. Undoubtedly these individuals were of neurotic disposition and the inflammatory signs were the outcome of trophic changes as well as vasomotor derangement in the nerves supplying the eyelids.

In the *treatment* of all these inflammations of the surface of the lids extreme care must be exercised to prevent the involvement of the conjunctiva and cornea and the likelihood of necrosis of these delicate structures. Strict cleanliness is therefore the most urgent principle of all forms of treatment, and in some instances one's care must be limited to efforts to maintain such cleanliness. Most of the forms of dermatitis are more or less limited in their effects and require only the use of soothing lotions, salves and powders. In the case of gan-

grenous processes sloughing may be accelerated by hot, saline solutions into which laudanum has been dropped, and the system must be supported by tonics and stimulants as well as by enriched diet.

The erythema caused by heat requires only mild dusting powders. Deeper burns would need antiseptic lotions and ointments. In mild X-ray burns, soothing powders or glyceroles are all that is required. More serious lesions may call for boric acid ointment with five or ten minims of carbolic acid to the ounce. In the case of dermatitis due to poisonous plants a lotion containing boric acid and bismuth subgallate in glycerine and rose-water is efficacious. A great number of remedies have been declared to be specific in this affection, but as the disease usually subsides of itself in a few days, their usefulness may be questioned.

In the *treatment of drug eruptions* of course the use of any substance causing the inflammation must be discontinued. Only simple external applications are needed. Free elimination must be sought, as by the administration of laxatives and diuretics, the best of which being copious draughts of water.—(B. C.)

Dermatoautoplasty. Skin-grafting with grafts taken from the patient's body.

Dermatobia noxialis. Bot-fly. Oestrid. The larvæ of this dipterous insect has been found in the conjunctival sac. Gradenigo (*Revue génér. d'Ophtalm.*, Vol. 13, No. 5) describes the appearance of these animals in the swollen, reddened and painful upper lid of a child; also in South and Central American natives. Key (*Brit. Med. Jour.*, Feb. 10, 1900, p. 316) describes conjunctivitis and dacryocystitis, together with increased intraocular tension, as results of this parasitic disease. In one case there was a small opening in the caruncle through which a small, moving opalescent body could be seen. Through this opening a dermatobia was extracted.

Dermatoheteroplasty. Dermatoplasty by means of grafts taken from the body of another than the patient.

Dermatology and ophthalmic diseases. The minor rubrics under this heading will be and, in part, have been discussed under various and appropriate captions in this *Encyclopedia.* See, for example, **Dermatitis**; **Cutaneous geromorphism**; **Herpes**, etc.

Dermatorrhagie. (F.) Cutaneous hæmorrhage. Hematidrosis. Hæmatidrosis. Bleeding from the skin.

Derme. (F.) Skin.

Dermo-epithelioma. Parinaud gave this name to a semi-transparent tumor, generally congenital and usually found near the sclero-corneal junction. Oatman prefers the term *epithelial cystoma of the con-*

junctiva, which he believes presents a transitional stage in the development of the epithelial cyst.

Vollaro (*Ann. d'Ocul.,* Vol. 144, p. 276, 1910) describes the characteristics of benign tumors of the conjunctiva of the type of dermo-epitheliomata of Parinaud. They are composed of two different types of elements derived from the epithelium of the bulbar conjunctiva. The cells of the primary type preserve distinctly the character of embryonal epithelium and form the epithelial globules and posteriorly, the cyst cavity. The second type is much more numerous and represents the mass of the neoplasm and morphologically differs very little from mesodermal elements. From the clinical and histological characters it would seem probable that non-pigmented cysts have their origin in the epithelium of cutaneous nevi.

Dermoidcysten der Lider. (G.) Dermoid cysts of the eyelids.

Dermoidgeschwülste. (G.) Dermoid tumors.

Dermoids. Ocular dermoids in general. Dermoid cysts of the eye. Congenital cyst. The essential histological feature of dermoid cysts is their epithelial lining which, however, is frequently very atrophic and variable in thickness. Hairs, sebaceous glands and occasionally other dermal structures, such as sweat-glands, are also found as a part of the cyst wall. The epithelium may be well-developed, like epidermis, with papillæ, but more commonly, or over the greater part of the surface, it is rudimentary and composed of one or two layers of flattened, ill-formed cells. The cysts are generally unilocular, but may be multilocular, probably by secondary adhesions. Whenever the epithelium is destroyed by inflammatory or ulcerative changes, it is not reformed. The hairs are thrown off and lie imbedded in the mass of granulation tissue which has resulted from the degenerative change, resulting probably from the continuous over-distension of the cyst (Mitvalsky). The contents of the cyst are composed of the secretions of the glands—sebaceous material and sweat—together with cast-off hairs and corneous epithelium. Various theories have been advanced to account for dermoid cysts. Lebert, in 1852, brought forward a theory of "plastic heterotropia," whereby under the influence of perverted nutrition normal tissues may give rise to other tissues or even organs. There is no evidence in favor of this theory, outside the domain of malignant tumors. At the same time this theory was being discussed Verneuil propounded a theory of dermal inclusion, which has been generally accepted. This theory states that the dermoid cyst arises from the inclusion of a pouch of skin which is invaginated into the deeper tissues during fetal life. The facts are best explained by this theory, and it is also strongly supported by the site of election

of the cysts—at or near the sites of fetal sutures and clefts. The theory of diplogenesis, or of an included fetus is unnecessary and improbable as an explanation of ordinary dermoid cysts, but it is difficult to explain the rarer teratoid tumors without having recourse to it.—(Parsons.)

Dermoid cysts are usually accompanied by some other abnormality, the most important and most frequent being coloboma of the lid. Other complications that have been met with are: of the eye, microphthalmia and coloboma of the iris and choroid; of the other parts of the body, preauricular tumors, macrostoma, harelip, absence of external auditory meatus, and syndactylism.

Dermoids of the different structures of the eye will be discussed under their proper headings.—(C. P. S.)

Dermoid cysts of the eyebrows. In connection with the eyebrows or lids, dermoid cysts are not uncommon; they have been met with deeply situated in the orbit, in which case it is very difficult to diagnose them from other orbital growths, and also to remove them completely. See, also, **Cysts, Dermoid, of the eyelids.**

Dermoid cyst of conjunctiva. When this form of tumor is found in the conjunctiva it is always congenital in origin, and generally a flat solid mass of a reddish or whitish color. It is nearly always associated with some other malformation or defective development of the eye, particularly coloboma of the lids or other parts of the face, as harelip. The corneo-scleral junction is the most common site, and in such cases the conjunctiva of the cornea is involved in the growth. They were given the name by which they have since been known, by Ryba, who first described them, in 1853. They demand removal principally for cosmetic reasons and on account of their inconvenience. There is a tendency to reproduction unless the whole tissue is thoroughly removed.

Ellett (*Memphis Med. Jour.*, March, 1909) removed a dermoid of the conjunctiva cornea and sclera from the left eye. A similar growth had been removed from the other eye. The right upper lid had a congenital notch. The growth contained irregular bands of unstriped muscle and a few hairs. See, also, **Cysts, Conjunctival and subconjunctival.**

Dermoid cyst of caruncle. Congenital telangiectasiæ and dermoid cysts have occasionally been observed in this region.

Dermoid cyst of the cornea. Primary dermoid tumors of the cornea are extremely rare, most of the growths involving this structure having their origin in the conjunctiva. Dermoids have occasionally been reported by competent observers. They occur generally as a firm,

hemispheric, yellowish-white growth, lying partly upon the cornea and partly upon the conjunctiva. The apex, often paler than the rest of the growth, is covered with short hairs; occasionally, however, they grow to unusual length, even protruding through the fissure of the lids and hanging down upon the cheeks. If undisturbed, the tumor may slowly enlarge, about the time of puberty, and it is at this time that hairs begin to grow from them, which give rise to conjunctival irritation. Wardrop, in 1834, described a case in which more than twelve long and strong hairs grew from the middle of the tumor and passing between the eyelids, hung over the cheek. These hairs did not begin to grow until the patient reached his sixteenth year, at which time his beard also began to grow.

Two cases under observation at about the same time, of corneal dermoids are described by Burton Chance (*Ophthalmology*, July, 1913). The first, was a Russian boy of fifteen years. A tumor, occupying an area of 3x7 mm. on the sclera and cornea, was present, and had been since birth, but was regarded as a birth-mark by his parents and, therefore, of no consequence. It was of a pearl-gray color and protruded between the closed lids. A few stiff hairs projected from its summit. It was dissected from the sclera and cornea, to which it was intimately attached, and the conjunctiva sewed over the raw area. The other case was in a thirteen-year-old Italian girl and was in the same position, lower temporal quadrant, on the cornea and sclera. It was not as large as the tumor in the former case, but was more pink, and the parents feared it was growing and might be malignant. It was more on the sclera than cornea. The same method of removal was carried out in both cases. Healing was uneventful. The subsequent examination of the tumors disclosed many characteristics in common, namely fibro-elastic tissue, chiefly with a covering of laminated, squamous epithelium. Fat-cells, sebaceous glands and hair follicles with their retained shafts were common to each. In the case of the girl, there were epithelial islands and much pigment, which indicated that pathologic activity was going on.

The histology of the enucleated eye of a man, aged twenty, who had a congenital, yellowish-white tumor of the cornea of the size of a hazelnut, over which he could not close the lids is given by R. Tischner (*Klin. Monatsbl. für Augenheilk.*, July, 1911). The eye was of normal tension, not irritated and not painful, but blind. The dermoid occupied the whole cornea and encroached upon the sclera. The iris touched, and partly lay against the lower half of the cornea; as also did the shrunken, partly calcified lens. The exact cause or origin of these dermoids cannot be given. Besides amniotic adhesions, whose

frequency seems to be over-rated, fetal keratitis, non-inflammatory disturbances in the eyeball, scattering of the germs, etc., may play a part.

Dermoid of the orbit. These relatively common cysts were first described as meliceerides or honey-cysts, by Pierre de Marchetis, in 1640. They were first called dermoids by Lebert, in 1852. True dermoid cysts are invariably congenital. They usually occur either at the inner or outer angles of the orbit, manifesting themselves as rounded tumors under the skin. They vary in size from that of a pea to that of a large orange; like dermoids in other situations they are liable to take on rapid growth at the time of puberty. Para-orbital cysts are frequently seen, usually situated at the outer or inner extremity of the eyebrow, sometimes extending onto the temple. They are not adherent to the skin, which moves freely over them, but they are generally adherent to the bone, or if not, there is often a depression in the bone. Dermoid cysts of the orbit are usually unilocular, though they may be multilocular, and their walls are quite thick, very vascular, and generally lined with epithelium. They may be closely connected with the muscles, or the eyeball, or the sheath of the optic nerve, or the periosteum. Their contents may consist of epithelium or epidermis, hairs, fluid fat and fat crystals, fluid or gelatinous or solid constituents, and even skin and teeth, with occasionally chalky deposits. See, also, **Cysts of the orbit.**

Dermo-lipoma. These tumors are composed of fibrous and fatty tissue, and are of congenital origin. They are usually found in the same situation as *dermoids* (q. v.), namely at the outer margin of the cornea or between the insertion of the superior and internal recti. They are usually yellowish in color and above the size of large peas. Parsons (*Pathology of the Eye*, p. 135) describes them as consisting mostly of fatty tissue with irregular strands of fibrous material. Lagrange says that true lipomata may be distinguished from dermo-lipomata in that the conjunctiva moves freely over the former but is adherent to the latter.

Descartes, Law of. In *refraction;* the ratio between the sine of the angle of incidence and the sine of the angle of refraction is constant, whatever may be the angle of incidence, as long as two media remain the same.

Descartes, René. "The father of the newer philosophy." His Latin name was Cartesius, and his nickname (from a small estate which he inherited) Du Perron. Born at La Haye, Touraine, France, March 31, 1596, he received almost his only education, from 1604 to 1612, at the school of La Fléche, a Jesuitical institution which had just been

founded by the king. When sixteen years of age, he returned to the house of his father, now at Rennes, and there took lessons in horsemanship and fencing. One year later he went to Paris to enjoy the pleasures of dissipation, but soon becoming disgusted by the useless life he was leading, and also by the political intrigues and horrors of the French capital, he removed to the Netherlands, where he soon took service in the army of the Prince of Orange. Two years later, his time of enlistment having expired, he proceeded to Bavaria, where he again enlisted, and was present with the Bavarian army at the battle of Prague. Free from service again, he travelled in various lands, and settled at last in Holland, where he lived many years. He died, however, in Sweden, February 11, 1650.

The most of Cartesius's philosophy does not concern us here. We may, however, mention that his theories, "The sum of all the motion in nature is unalterable" and "Heat becomes motion, and motion heat," he forestalled, or at least to some extent anticipated, the well known doctrines of the "Conservation of Energy" and "the Mechanical Equivalent of Heat." By his declaration that the bodily functions are based upon the molecular motions of the solid and the liquid tissues, he gave their cue to the two great medical systems of the 17th and 18th centuries—the so-called "iatrophysical" and "iatrochemical." He also asserted that sound and light (the latter including color) were also merely modifications of motion. He did not, however, believe that the action of light occurs by means of vibrations of the ether, but, instead, "by the propagation of direct motion from one minute particle of subtle matter to the next, and so on in right lines, till the last of the series affected the eye." He hence believed, almost as a necessary corollary, that the passage of light through space takes place instantaneously, "as a blind man feels with the end of a stick." The existence of the different colors he could not (as a necessary consequence) explain by different velocities and wave-lengths, but only by a rotary motion of the particles that act directly on the eye. The rapidest rotary motion of all, gives red; the next most rapid, yellow; while blue and green can occur only when the rotary motions are slower than the direct. In his Sixth Discourse, he thoroughly expounds the perception of distances, anticipating all that Berkeley stated, years later, on this important topic in his "Theory of Vision." (See **Berkeley, George,** in this *Encyclopedia.*)—(T. H. S.)

Descémétite. (F.) Descemetitis.

Descemetitis. Punctate keratitis. Serous iritis. Inflammation of Descemet's membrane. This is a condition which occurs in inflammatory states of the uveal tract (iris, ciliary body and choroid) and

consists of deposits of fine dots of lymph, mainly from the ciliary body, on the posterior surface of the cornea. It is merely one symptom of a deep-seated disease and has nothing to do with an inflamed cornea. The dots are usually arranged in the form of a triangle with its apex pointing toward the center of the pupil. Sometimes the whole of the posterior corneal surface is so covered.

Opin (*Archives d'Ophtalmologie*, 1911, Vol. XXXI, p. 501) studied the changes in an eye enucleated for iridocyclitis with secondary glaucoma. He found multiple and elective changes in the endothelium of the anterior chamber which corresponded to opacities and deposits on the posterior surface of the cornea, which had been observed before operation. The three points of interest are: (1) the nature of the cellular deposits on the posterior surface of the cornea; (2) the origin and evolution of the cellular layer which lined a great part of the posterior surface of the cornea; (3) the curious degeneration undergone by the epithelial elements which had fallen into the anterior chamber.

(1) Contrary to Fuchs' belief, he believes that they are really cells from Descemet's membrane: (a) because the ciliary processes were completely atrophied, and there was no sign of lymphocytic infiltration at the ciliary processes or iris; (b) it would have been impossible for the cells to have passed through the fibrinous exudate and applied themselves to the posterior surface of the cornea—they must have originated at or near the place they were found; (c) their origin can actually be seen at the border of Descemet's endothelium; the cells are detached, project outward, segment and then fall into the anterior chamber. Sometimes they are in masses, the youngest cells of which are those closest to the endothelium. Consequently the clinical term of descemetitis is pathologically correct. (2) They are endothelial cells which have undergone a transformation into fixed, anastomosing cells. It is possible that they later secrete collagene, and thus form the connective tissue layer which Bartels saw. (3) The endothelial cells become vesicular owing to the presence of the serous or purulent secretion. Sometimes this forms around the nucleus; sometimes there is a formation of two nuclei; or there may be in addition karyokinesis; in fact, the different appearances can all be explained as the result of a process of karyokinesis, multiplying the number of nuclei, accompanied by cellular imbibition and vesicular alterations of the protoplasm. (Abstract in the *Annals of Ophthal.*, Jan., 1912.)

The *treatment* of this serious affection must follow the particular variety of uveitis assumed by the disease of which it is a part. Generally speaking, the most satisfactory local applications are atropia

and dionin in full doses. When the tension is decidedly increased paracentesis or iridectomy, followed by hyoscine, may be substituted for atropine, since an iritis is invariably present, and the employment of eserine or pilocarpine is pretty sure to be followed by posterior synechiæ, with loss of eyesight and, perhaps, total destruction of the eye. The latter drug used hypodermically in from 1/12th to ¼th grain doses, acts admirably in almost all phases of the disease, especially when combined with iodides internally and sweat baths. It is well to use them for two-week periods alternately with sodic salicylate, administered as Gifford recommends.

With the foregoing as adjuncts any general or local condition likely to aggravate or to produce the uveitis should be attended to—nasal disease, gout, syphilis, etc. Radium has been spoken of by C. H. Williams as helpful in encouraging the absorption of the exudates. See **Keratitis, Punctate.**

Descemet, Jean. A famous Parisian ophthalmologist, for whom is named "the membrane of Descemet." Born at Paris, April 20, 1732, he became well-known as botanist and general physician, as well as ophthalmologist. He is chiefly remembered because of his discovery of the basal membrane of the cornea, above-mentioned. Even in this matter, however, his priority was long contested by Demours, whom he would seem, at length, to have defeated definitely. Descemet's chief writing was entitled "*An Sola Lens Crystallina Cataractæ Sedes?*" (Paris, 1758; it contains the first description of the corneal basal membrane). Two years before his death, Descemet was appointed to a teaching position in the newly-erected Royal Lyceum at Paris. He died at his country house near St. Denis, October 17, 1810.—(T. H. S.)

Descemetocele. Hernia of Descemet's membrane.

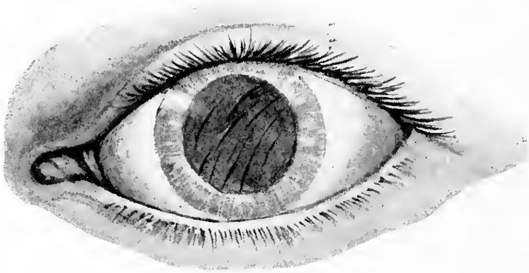
Descemet, Rupture of the membrane of. FISSURES OF DESCEMET'S MEMBRANE. CLEFTS OF DESCEMET'S MEMBRANE. As Stephenson (*The Ophthalmoscope*, June, 1906) pointed out, clefts, fissures or linear ruptures of the membrane of Descemet are the result of morbific processes (particularly stretching of the parts) inherent in buphthalmos, keratoconus, intraocular tumors and progressive myopia. The clefts are evidenced by curious curved lines lying at the posterior surface of the cornea. Two cases are reported by him, one in a woman of twenty-one years with myopia of about 12 D., and the other in a child of six months with buphthalmos.

The Editor (*Ophth. Rec.*, Dec., 1906) has described (see the figure) a similar case, in this instance due to, or associated with, a high degree of myopia. See, also, page 2289, Vol. III, of this *Encyclopedia.*

Fissures in this membrane of the eye of a child, aged fifteen months,

with an enormous keratectasia are described by Alt (*Am. Jour. Ophthalmology,* May, 1907). There were two double contoured gray lines in the back of the cornea almost concentric with the periphery. As tension was increased and a growth was seen through the hazy cornea in the depth of the vitreous, enucleation was performed. A good-sized glioma was found, which in one part reached forward to the lens. The rents in Descemet's membrane were found covered with endothelium, which had also grown over a new-formed lamina vitrea. Bowman's membrane was also wanting for some distance opposite the breaks.

Coats (*Trans. Oph. Soc. U. K.*, Vol. 27) describes the various forms which rupture of Descemet's membrane may take and the subsequent



Clefts in Descemet's Membrane Accompanying a High Degree of Myopia. (Casey Wood.)

changes which they undergo, giving the results of his observations in cases of infantile glaucoma, myopia and conical cornea. He furnishes a historical account of rupture of the membrane of Descemet from the first anatomical description of this condition as given by Becker in 1875. He then gives his personal observations based on the study of 13 cases of buphthalmos, 8 of glioma with increased tension, and 4 of myopia of high degree. Ruptures were found in all cases of buphthalmos except one. In 8 cases of glioma they were present twice, while he failed to find any in uncomplicated myopia, but found them in 1 case of myopia associated with glaucoma. The author attributes their absence in high myopia to the fact that in myopia it is the posterior hemisphere of the globe that stretches and not the anterior. Coats states that in microscopic preparations the fissures are more numerous and extensive in the periphery of the cornea where the stretching and thinning is greatest in buphthalmos. In the author's cases the endothelium was always intact over the gap, and he believes that the preservation of the transparency of the cornea is due to that fact.

He mentions a rare form of rupture in which overlapping of the edges occurs instead of spreading apart, due to a relaxation of the heightened intraocular tension after the occurrence of the rupture. The subsequent changes consist of processes of repair by the deposition of new membranes, or masses of similar substance, from the endothelium, and this occurs in an imperfect manner.

The author gives the essential cause of rupture of Descemet's membrane as stretching of the cornea, and states that the term "elastic" as applied to it is a misnomer and that it is inferior in elasticity to the corneal lamellæ, as evidenced by the fact that when divided it assumes curly and spiral forms instead of retaining its original form.

Notes are given on clinical cases, the article is illustrated and a bibliography is appended.

Marc Landolt (*Arch. d'Opht.*, XXX, ii., November, 1910) says of these ruptures of Descemet's membrane that they present themselves as sharply-defined lines of double contour, occasionally showing sharp bends, and usually situated in the paracentral region of the cornea. Increase of tension alone does not cause the ruptures; an increase of tension in a young eye whose tissues are stretched by the raised intraocular pressure is the determining factor; enlargement of tissues as in keratoglobus not due to hydrophthalmia, in Haab's opinion, will be found to be unaccompanied by the ruptures. Ruptures of Descemet's membrane were familiar to pathologists before clinicians gave much attention to them; at first they were regarded as artefacts. Gepner was the first to produce specimens showing repair of such ruptures in buphthalmic eyes.

Landolt concludes that the site where rupture of Descemet's membrane will occur is very variable; that these variations depend in part upon the age of the patient, when the stress of hypertension developed and on the rapidity of its onset; that in most buphthalmic eyes a study of Descemet's membrane leads to the conclusion that the aqueous is more a filtration product of the vessels of the ciliary processes and iris than a secretion product of the ciliary cells.

Descemet's membrane. Membrane of Demours. This is the internal or posterior lining membrane of the cornea. It is a homogeneous elastic lamina, extremely delicate up to the tenth week of fetal life and not fully developed until the fifth month. Descemet's membrane is covered posteriorly by a single layer of endothelial cells continuous with the covering of the iris. These cells are polygonal and have distinct nuclei. For a further description of this important layer, see **Histology of the eye**; as well as Vol. I, p. 370, of this *Encyclopedia*.

Descending neuritis. DESCENDING NEURO-RETINITIS. Von Graefe, as the result of the ophthalmoscopic study of cases of intra-ocular optic neuritis occurring in meningitis, assumed that the morbid process extended from the cerebral meninges along the course of the nerve. Hence the term descending neuritis. This condition is characterized by moderate swelling of the nerve-head, slight discoloration of the disc, slight changes in the vessels, and the presence of an exudation, which causes opacity of the papilla. The process tends to extend to and involve the retina.—(J. M. B.)

Deschales, Claudius Franciscus (1621-1678). A Jesuit Father; professor of physics first at Marseilles, later at Lyons. He wrote a colossal treatise in three thick folio volumes entitled, "*R. P. Claudii Francisci Milliet Deschales Cambriensis e Societate Jesu Cursus s. Mundus Mathematicus*, Lugduni, 1674." One division of this treatise, called "De Oculorum Suffusionibus, muscis et Aliis Hujuscemodi" contains a passage of very great interest to ophthalmologists, forming, as it does, the first correct pronouncement of the true seat and nature of muscæ volitantes. The passage in question is as follows: "Once I attended a consultation of rather skilful physicians concerning one of our own number, who saw before him almost continually a floating mark, like a suspended fly, which sat upon every object looked at. The physicians explained that it was the trace of a cataract in the pupil. One of them, more sharp-sighted than the others, would actually see the mark in the middle of the pupil. I explain that a very small black body in the pupil, which is not close thereby, would have caught a ray from every object; and it cannot be seen, because of lying too close to the crystalline body, for the rays which proceed from it to be able to unite at the retina.

"In an experiment with the artificial eye, the small spot upon the pupil does not appear upon the retina when this stands at the correct distance; all that happens is that the coloring of the image is less intense.

"The same thing is true, furthermore, concerning opacities of the cornea.

"Thirdly, I declare that that dark spot may be a bulla in the vitreous humor, pretty close to the retina, because, in order to appear to be fixed upon a visual object, it must cut off from the given object either all, or the most, of the rays. Let A and B be objects, which send rays into the pupil CD, so that the rays belonging to A unite at E, and those sent out from B in F. Let us conceive of a very small dark object either in the pupil CD or in the lens GH or even in that part of the vitreous humor which lies nearest to the lens; then one of

the rays from A will be intercepted, and also one from B; therefore no ground exists wherefore the spot should appear rather at A than at B. The same holds true of the cornea. When, however, a dark point exists in the vitreous humor just in front of E, then it can intercept all the rays from the point A and thus it can appear as if in an object at A there were some defect; there can, in fact, appear to be a dark spot upon it.

"For still more probable I hold this, that often in the retina such a defect is found, since the retina often hardens in places and receives no impression from the object. Then there must appear in the object a black spot. This spot, however, will not appear to be fixed, but movable.* For we do not turn the same part of the retina immovably upon the same part of the object, but we contemplate first this object, then that.

"Such a condition occurs in those who have gazed at the sun, because the retina has been injured."

Thomas Willis (*q. v.*) preceded Deschales in the view that defects of the visual field might be due to abnormalities of the retina, but he made the great mistake of supposing that, to this cause were to be assigned the *muscæ volitantes* instead of those defects which bear a fixed relation to macular (central) vision.—(T. H. S.)

Désenflure. (F.) Recession or going down (of a swelling).

Desensitization. The use of concentrated or globulin antitoxin has reduced the case incidence as well as the severity of serum sickness. It is now believed that by proper precaution it is possible to practically eliminate the danger of sudden collapse. Experiments on the lower animals have demonstrated that sensitization to a specific protein can be destroyed—in other words, that the animals can be desensitized by the injection of a very small amount of the protein, so that subsequently large doses of serum or other protein can be given without the production of toxic symptoms. The desensitization of the human subject is therefore suggested as a rational procedure, and has been tried on an extensive scale. Besredka, of the Pasteur Institute in Paris, offers the following method of procedure: "By making serum

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* With regard to this particular point, Hirschberg condemns Deschales in the following language: "Aber auch D. hielt sich von Irrthum nicht frei, indem er die von kleinen netzhaut-Defekten abhängig schwarzen Flecken auf den Gegenständen für beweglich heilt und nicht scharf von den fliegenden Mücken zu trennen vermochte." But "D." does not seem to have been really in error. He merely employs the term "movable" in a sense different from that in which it is used by Hirschberg. Deschales, by "movable," means, manifestly, "movable as the eye itself moves." Hirschberg, on the contrary, thinks of the word as meaning "movable with reference to macular, or central, vision. Like so many other differences of opinion, this one also resolves itself merely into one of definition.

injections into veins, first a drop, a half-minute later a few, then after a little time some more, and so on, we may safely inject any size of dose of serum without fear, the whole not requiring more than five minutes more time than we give to the same operation when taking no precaution. The increased safety is well worth the extra time." The more common procedure is to inject subcutaneously or intramuscularly a few drops of the serum (0.1 c.c.) and to withhold the balance of the injection for a period of from one-half hour to an hour. (Parke Davis & Co. *Manual*, p. 27.)

Desert blindness. This condition is comparable or is analogous to snow-blindness (q. v.). The excessive brilliancy of the sun-illumined white or yellow sand of the desert affects the anterior structures of the eye as well as the retina. The excessive heat of the day combined with the often intense cold at night are also contributing causes.

Déshydratation. (F.) Dehydration.

Desiccated thyroid glands. See **Thyroid extract.**

Desichthol. Deodorized ichthyol. This is a preparation produced from ichthyol by the removal of about 5 per cent of volatile oil, to which the disagreeable odor is due. See **Ichthyol.**

Desmarres' depletion. This little operation consists in the section of a subconjunctival vessel, which is permitted to bleed freely. It is a measure that will often relieve the pain in and check the advance of most forms of iritis and cyclitis.

Desmarres, Louis-Auguste. A famous Parisian ophthalmologist, who was born at Evreux, France, September 22, 1810, and died at Neuilly, August 22, 1882. At first he was the steward of an estate, later he gave violin and water-color lessons to defray his college expenses. Studying at Paris, he received his medical degree in 1839. He became, by chance, an intimate acquaintance of the great Sichel, and was made by this master ophthalmologist his private secretary and the chief of his crowded clinic. In 1841 he established a private ophthalmic hospital of his own, which became a celebrated institution among students of ophthalmology. Among the pupils of Desmarres at this institution was the keenly observant Albrecht von Graefe, afterwards to become immortal as one of the founders of modern ophthalmology.

Always a brusque, rough, outspoken man, Desmarres attracted his listeners by the sheer force of his scientific merit. He had but little eloquence, and he made few friends.

Desmarres was widely-known for his routine employment of scarification and other forms of blood-letting in connection with various ophthalmic affections. For the purpose of scarification he invented an instrument which is still employed and is still known as the "scari-

ficator'' of Desmarres. He also invented a pterygium operation and an epicanthus operation, both of which are sufficiently described in the non-historical portions of this *Encyclopedia.* His cystitome, lid-clamp, and lid retractor, all in use to-day, are shown under appropriate headings in this *Encyclopedia.* He was really the discoverer of scleritis, though the disease had indeed been (barely) mentioned by von Ammon (1829) Velpeau (1840) Chelius (1843) Fischer (1846) and by various other writers in other years.

The most important writing of Desmarres was his *"Traité Theorique et Pratique des Maladies des Yeux."* (Pp. 904, avec 78 figures intercalées dans le texte, Paris, 1847. German translation, elaboration and enlargement by Seitz and Blattman, Erlangen, 1852. 2d French ed., 3 vols., 1854-58.) This was a very remarkable text-book, the best, in fact, that had ever appeared in any language at the time of its publication.

Desmarres's other publications are as follows:

1. Epicanthus Accidentel Temporaire Survenu pendant le Cours d'une Conj. Purulente et Ayant Disparu après cette affection. (*Annales d'Oculistique,* VI, p. 236, Fevr., 1842.)

2. Sur une Nouvelle Méthode d'employer le Nitrate d'Argent dans quelques Ophthalmies par M. Desmarres, Chef de Clinique de M. Sichel. (*Op. cit.,* VII, pp. 45. 105, 259.)

3. Mèmoire sur les Dacryolithes et les Rhinolithes. (*Op. cit.,* VII, p. 149; VIII, pp. 85, 201; IX, p. 21.)

4. Sur la Guérison des Taches Anciennes de la Cornée par l'Ablation des Lamelles Opaques. (*Op. cit.,* IX, p. 96.)

5. Keréctomie ou Abrasion de la Cornée dans les Opacités Anciennes de cette Membrane. (*Op. cit.* X, p. 5.)

6. Note sur la Kératoplastie. (*Op. cit.,* X, p. 183.)

7. De la Cataracte Pigmenteuse ou Uvéenne et de son Diagnostic Différentiel. (*Op. cit.,* XIII, p. 132.)

8. De l'Emphysème des Paupières. (*Op. cit.,* XIV, p. 97.)

9. Synchisis Etincelant. (*Op. cit.,* XIV, p. 220.)

10. Nouvelles Observations de Synchisis Etincelant. (*Op. cit.,* XVIII, p. 23.)

11. Cholesteritis de l'Oeil. (*Op. cit.,* XXIV, p. 195.)

12. Examen des Yeux ou Ophthalmoscopie. (*Op. cit.,* XVI, pp. 13, 122, 291.)

13. Nouvel Instrument pour l'Exstirpation des Tumeurs des Paupières. (*Op. cit.,* XVI, p. 3.)

14. Recherches Pratiques sur la Parancènthese de l'Oeil. (*Op. cit.,* XVIII, p. 255.)

15. Formule pour la Préparation des Crayons de Nitrate d'Argent et de Nitrate de Potasse. (*Op. cit.*, XX, p. 157.)

16. Observations Prat., etc. (*Op. cit.*, XXIII, p. 7.)

17. Guérison du Ptérygion par un Nouveau Procédé, Dit par Dérivation. (*Op. cit.*, XXV, p. 207.)

18. Extraction des Cataractes Fausses Membraneuses Secondaires au Moyen de la Serretèle. (*Op. cit.*, XXVI, p. 166.)

19. Note sur la Phlebotomie Oculaire. (*Op. cit.*, XXVIII, p. 153.)

20. Du Larmoiement. (*Op. cit.*, XXXI, p. 86.)

21. De l'exophthalmos Produit par l'Hypertrophie du tissu Cellulo-Adipeux de l'Orbite. (*Op. cit.*, XXXIV, pp. 273, 283.)

22. Inflammation des Os et du Perioste de l'orbite. (*Op. cit.*, XXXIV, p. 275.)

23. Ankyloblepharon Artificiel dans un Cas de Paralysie Rebelle de la 7e Paire. (*Op. cit.*, XXXIV, p. 276.)

24. Oblitération du Sac Lacrymal au Moyen du Chlorure de Zinc. (*Op. cit.*, XXXVIII, p. 44.)

25. Indications et Contre-Indications de l'Oblitération du Sac Lacr. (*Op. cit.*, XXXVIII, p. 44.)

26. Tumeur Fibroplastique de la Chambre Antérieure. (*Op. cit.*, XXXVIII, p. 100.)

27. Note sur une Espèce peu Connue de Tumeur de la Chambre Antérieure. (*Op. cit.*, XXXVIII, p. 191.)

28. Compte Rendu de la Traduction du Traité Pratique sur les Maladies de l'Oeil de W. Mackenzie, Faite sur la 4e Edition, par Warlomont et Testelin. (*Op. cit.*, XXXVIII, p. 103.)—(T. H. S.)

Desmeux. (F.) Ligamentous.

Desmonceaux. A priest, physician and ophthalmologist of the 18th century, to whom has been improperly assigned the honor of first proposing the removal of the transparent lens in high-grade myopia. Born at Paris in 1734, he became very early a priest, but, in consequence of a most ardent desire to be of the utmost possible service to the sick, he studied medicine, surgery and ophthalmology in his leisure hours. His medical, surgical, and ophthalmologic services he gave to all without money and without price, and, on these terms, he became extremely popular.

Among his writings are "*Lettres et Observations Anatomique, Physiologiques et Physiques, sur la Vie des Enfants Naissants*" (Paris, 1775) and "*Traité des Maladies des Yeux et des Oreilles Concidérés sous le Rapport des Quatre Ages de la Vie de l'Homme*" (2 vols., Paris, 1786).

No copy of the ophthalmologic work has been accessible to me.

Hirschberg speaks of it with great contempt, calling it, *inter alia,* "schwach und elend." The only important passages in the two volumes would seem to be those in which the extraction of the transparent lens for the relief of high-grade myopia is mentioned. These passages, *via* Hirschberg's German translation, I render thus: "Myopes with a 2 to 3 inch focus are very unfortunate persons, because they see very indistinctly even what lies at their feet; they are consequently little inclined to work. Therefore, I advise that, while these patients are still young, their lenses be extracted; a procedure which lessens the stretching of the cornea and renders the images of objects more perceptible. This operation, as I have indicated in a little work of the year 1776, is less to be dreaded than that for cataract, because an unaltered lens, after the opening of the capsule, comes out easily. This aid to myopes of the highest grade was neither known or practicable before the operation of extraction and can only be of the greatest use to all who have to work." The second passage: "A cataract is not the only thing that renders a corneal incision necessary. The extreme myope is occasionally in this situation, if one accepts that the cause of this disease consists of too great a volume of the lens-body. For I have often seen this operation performed with success, because every lens, in whatsoever state it may be, can be extracted, and because from this operation, the extreme myope receives a real advantage, a condition which renders easy the perception of objects." Desmonceaux did not himself profess to have performed the operation in question. In fact, he admitted the contrary. Thus, in another book of his, published at Paris in 1775, under the title "*Lettres et Observations Anatomiques, Physiologiques, et Physiques sur la Vie des Enfants Naissants*" (a work discovered by Panas in 1897) occurs the following passage: "This kind of operation will appear to be new, but it succeeds and will almost always succeed in the skilful hand of Baron Wenzel, who has tested it many times and has had the charitableness to operate on such indigent patients as turn themselves to my poor light."

So Desmonceaux did not himself perform the operation. The question remains, however, as to whether he was or was not the first to propose the procedure. The answer to this is very plainly in the negative. Albrecht von Haller, in 1763 (twenty-three years before the date of Desmonceaux's "Traité") published a work entitled "*Elementes Physiologia*" in which he has these words: "A short-sighted person is helped chiefly by extraction or reclination of the crystalline lens, by which procedure the strength of the ray-convergence in the eye is diminished to a notable degree." However,

even Haller does not profess to be the first either to perform or to propose the extraction of the transparent lens for highly-developed myopia. Thus, in another work of his, *Bibl. Chir.* (vol. II, p. 405) he presents this note: "Joseph Higgs, Chirurg. Birminghamensis, a Practical Essay on the Cure of Venereal, Scorbutic Arthritic, Leprous, Scrophulous and Cancerous Disorders. In a Method Entirely New. London, 1745. (4°). Myopian depressa lente crystallina curavit." Now, in Higgs's book, the passage in question is as follows: "Some years ago, I proposed to Dr. Desaguliers a Method for Relieving near-sighted persons, by depressing the Crystalline humor, as in couching; inasmuch as, when that medium is removed, one of a less density will succeed, which will supply the place of Glasses. But the experiment I have never as yet tried."

Thus we may say, by way of conclusion to the whole matter:

1. Reclination of the transparent lens as a means of relief in high-grade myopia was first proposed by Joseph Higgs, of Birmingham, England, in 1745.

2. Extraction of the transparent lens for the same purpose received its earliest traceable mention from Albrecht von Haller, who, however, does not profess ever to have performed the operation or to have been the first to propose it.

3. It is likely that the first actually performed reclination and extraction for the relief of myopia were done "by the skilful hand" of Baron Wenzel (senior, not junior) some time prior to 1775, at the re-suggestion of Father Desmonceaux.

The later history of the subject is, in brief, as follows:

In 1799, Joseph Beer speaks of the operation, but only with disapproval. He seems never to have performed it.

In 1822, Weller, in 1825 Benedict, in 1834 Andreæ, in 1839 Radius, all speak of the operation, but none appear to have performed it.

In 1858 Weber and Mooren seem actually to have done this operation.

In 1889, Fukala, reviving the procedure in question, secured therefor a somewhat general acceptance.—(T. H. S.)

Desmoulins, Jean D. (*Latine*, Molinæus.) A botanist-physician of Lyons, France, who flourished in the 16th century. In his honor was named by Commerson a plant (*Molinea*) whose native habitat is the Isle of France.

Ophthalmologically, Desmoulins is of importance only because of a mistake—a mistake committed by Benedict, who, in 1825, confounding together Desmoulins (of the 16th century) with Desmonceaux (of the 18th century), assigns to the 16th century man the honor of first proposing the removal of the lens in high-grade myopia.

Much confusion resulted from the mistake. Otto complained bitterly that he was unable to find in the writings of Desmoulins the ophthalmologic passage which Benedict cites. And, as late as 1900, Pflüger remarks (page 1 of "*The Operative Removal of the Transparent Lens*") "Only the communication of Desmoulins concerning this operation remains to be found."

This mistake was discovered by the observant Hirschberg, who, in his "*Geschichte der Augenheilkunde*" remarks, "*This* Desmoulins has no existence."—(T. H. S.)

Desmurgie. (F.) The application of bandages or of ligatures.

Desquamative conjunctivitis. A synonym of **Conjunctivitis, Samoan.**

Desumvergence. A downward inclination of the eyes.

Detachable fronts. An arrangement by means of which one lens of a camera can be quickly changed for another.

Detached choroid. Detachment of the choroid. Choroidal detachment. This lesion is, apart from the post-operative accident of cataract extraction, rarely present without a corresponding detachment of the retina. In shrunken eyes it results from the same causes as the latter condition—a shrinking vitreous; indeed the pathogenesis of detached retina is much the same as that of detached choroid.

Fischer (*Arch. of Ophth.,* p. 153, 1909) examined an enucleated globe which showed copious retro-choroidal hemorrhage and detachment of the choroid following sclerotomy and iridectomy for glaucoma. The effusion was probably caused by the lowered tension rather than as the direct result of either operation. He also reports a similar occurrence following perforation of a corneal ulcer observed by Merz. It is quite possible that small detachments of the choroid after glaucoma iridectomy are more frequent than has been hitherto suspected

Meller (Graefe's *Arch. f. Ophth.,* Vol. 80, p. 170, 1911) divides detachment of the choroid into different groups; first, a post-operative detachment which follows shortly after operation and is of good prognosis; second, a late detachment several months afterward usually complicated with detachment of the retina and of unfavorable prognosis; third, spontaneous detachment of the choroid independent of operation, beginning in the anterior portion and mostly complicated with detachment of the retina. He assumes a reversal of the direction of the course of the fluids as the cause in these cases. Posterior spontaneous detachments of the choroid and retina he ascribes to a probable transudation from the choroidal vessels in both directions. The author calls attention to the many points still doubtful in the subject of choroidal and retinal detachment.

In choroidal detachment after cataract operation, according to

Rochon-Duvigneaud and Ducamp (*Ann. d'Ocul.*, Vol. 145, p. 213, 1911) who demonstrated this condition upon sections, the subchoroidal exudate consists only of blood-serum. Such post-operative changes are accordingly almost invariably the consequence of a general affection. See, also, Vol. III, page 2137 of this *Encyclopedia.*

Detached retina. DETACHMENT OF THE RETINA. RETINAL DETACHMENT. See **Retina, Detachment of the.**

Detacher, Fox's cataract. See Vol. III, page 1518 of this *Encyclopedia.*

Detacher, Savage's cataract. See Vol. III, page 1518 of this *Encyclopedia.*

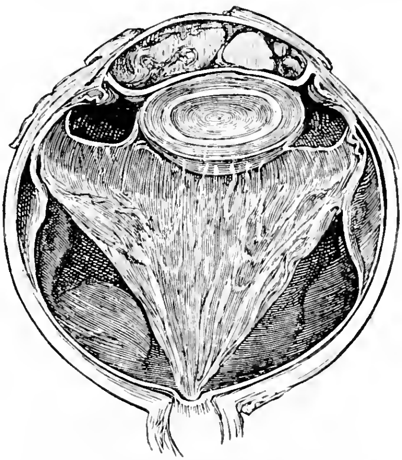
Detachment, Vitreous. This lesion, with sequent detachment of the retina, is the result of trauma, intra-ocular tumors, old inflammatory

Detachment of the Vitreous. (Parsons.)

From a man, æt. 56; traumatic dislocation of lens, globular detachment of vitreous, which passes forwards into the anterior chamber.

processes in the vitreous, choroiditis, hemorrhages, cyclitis, and posterior staphyloma. The condition is not diagnosticable until after enucleation. Some writers on ophthalmology profess to have foretold the condition in highly myopic eyes by reason of sudden diminution of vision, concentric contraction of the field, with the presence of a sharply-defined, crescentic, grayish zone around the papilla, within which the retinal vessels appear bent. That detachment of the vitreous humor is a frequent condition is shown by the statistics of Jennings Milles, who found it in 43 of 345 excised eyes.—(J. M. B.)

According to the account given by Parsons (*Pathology of the Eye,* p. 429) the vitreous may be detached from the posterior pole, either in small degree or until it lies as a hemispherical mass behind the lens (globular detachment, Milles). It is often tent-shaped (infundibular detachment, Milles), the apex of the cone being at the disc, or at a wound by a foreign body somewhere in the retina, or anterior at the site of a perforating wound. The detached vitreous always contains foreign inflammatory elements, and usually organizing connective tissue often mixed with blood. The outer surface is generally covered



Detachment of the Vitreous. (Parsons.)
From a man, æt. 61; injured five weeks previously with chip of iron. Ulceration of cornea, pus and blood in a. c., retraction of iris and lens, antero-lateral and infundibular detachments of vitreous.

with an endothelial membrane, which may consist of several layers, and is exactly similar in origin and appearance to membranes found on the retina. The cells may deposit fine hyaline membranes, which show a considerable amount of resistance. There may be a layer of connective or fibrous tissue, either loose and reticular or dense. The subhyaloid space is filled with extravasated lymph, which does not usually coagulate; it may contain blood. Antero-lateral detachment is occasionally seen, the vitreous being separated from the suspensory ligament. Detachment of the vitreous may be due to several causes:—(1) Pushing forwards, as in cases of subhyaloid hemorrhage. (2) Detachment *e vacuo* (Iwanoff), as in myopia, anterior staphyloma, sometimes in glaucoma, and possibly after cataract extraction owing to exudation of fluid from atheromatous retinal vessels. According to Elschnig, detachment of the vitreous does not occur in myopia. (3)

Pulling forwards. This is by far the commonest cause, and is due to the shrinking of exudates—fibrin (Leber) etc.—or of organizing connective tissue in the vitreous.

Déterger. (F.) To purify; To cleanse.

Determination of ametropia. See **Examination of the eye**; as well as **Refraction and accommodation.**

Deuteranopia. A term applied by von Kries to the second or double class of color-blindness, or green-blindness, or red-green-blindness with an unshortened spectrum.

Deuteroscopy. CLAIRVOYANCE. A form of hallucination or deception in which the pretender claims to be endowed with "second sight," and to be able to foresee and foretell future events.

Deutschmann's operation. See **Retina, Detachment of the.**

Deutschmann's serum. YEAST SERUM. POLYVALENT SERUM. According to Wood's *System of Ophthalmic Therapeutics* this is a polyvalent serum from rabbits fed on yeast, and prepared by R. Deutschmann (*Münch. Medizin. Wochenschr.*, No. 9, 1907; See Merck's *Reports,* 1908) by a special method. For this purpose increasing doses of yeast are introduced by mouth into the animal's body, and these are thought by the author to lead to the accumulation in the animal's blood of protective or defensive substances. The serum, obtained from such blood gives the human organism increased power of resistance in the battle against pneumococci, staphylococci, streptococci, etc., or their toxins. Injected into the muscles it is said to improve the general condition of patients, to reduce febrile temperature, while it is reported to be perfectly harmless. For adults doses of 3 to 4 c. c. are used, for children 0.75 to 1 c. c. Deutschmann considers the serum to be indicated in pneumonia, septic and pyemic infection, erysipelas, influenza, acute tonsilitis, severely infected wounds of the eye, hypopyon keratitis, relapsing iritis, irido-cyclitis, sympathetic inflammation (in which the exciting eye was not removed) and in tuberculosis.

Deneke (*Deutsch. Medizin. Wochenschr.*, No. 4, p. 172, 1908) tested the serum in 32 cases of croupous pneumonia, and came to the conclusion that its curative action was not proved. This view is also generally held.

Hippel (Graefe's *Archiv f. Ophth.*, Vol. 72, p. 301, 1909) gives experience with Deutschmann's serum in over 100 cases. His latest observations corroborate his earlier reports. The results since using it in the Göttingen clinic now show 50 per cent of cures, while before its introduction the cures numbered only 33 per cent. Other clinical observers do not give so favorable reports.

The results of treatment of 117 cases with his *polyvalent serum* are

more recently stated by Deutschmann himself (*La Clin. Ophth.*, Vol. 16, p. 195, 1910). These include forty-nine infected corneal ulcers, eighteen with and thirty-nine without hypopyon; the average time of treatment being fifteen and fourteen days respectively; thirteen cases of plastic iritis treated twenty-one days; and twenty-one cases of serous iritis treated thirty-three days, with various other infections. He claims the results are good; but does not state them very definitely, or give details that enable the reader to judge for himself. Infections of the vitreous body he admits are less favorably influenced. The favorable report of v. Hippel regarding Deutschmann's serum has been criticized by Axenfeld (Graefe's *Archiv f. Ophth.*, Vol. 75, p. 190, 1910), who thinks his evidence of doubtful significance. The unreliability of serum should at least forbid its exclusive use in serious cases.

Happe (*Klin. Monatsbl. f. Augenheilk.*, Schmidt-Rimpler *Festschrift,* p. 140, 1909) has reviewed the reported results of various forms of treatment with yeast and yeast derivatives, including Deutschmann's serum. In thirty-three parallel experiments, after inoculations with pneumococci and staphylococci, the serum appeared to be entirely without immunizing influence. Deutschmann (*Münch. Med. Woch.*, No. 11, 1909), however, recommends his serum unreservedly for suitable cases, since its harmlessness is confirmed by all investigators. The active principle being precipitated from the blood serum and dissolved in water, gives the form known as "serum E." The best results have been obtained in hypopion keratitis. Deutschmann knows no more potent remedy for infective ulcerations of the cornea. It exerts a favorable influence upon infective iritis, but is less efficient in vitreous inflammations.

He insists it must be given early. The dose recommended is 4 c.cm. daily, injected into the muscles of the anterior chest wall, while for children half this dose may be given. Hoffman, in discussion of v. Hippel's paper, speaks of using double the above dose daily with good results. Von Hippel (*Klin. Monatsbl. f. Augenheilk.*, July, 1909, p. 111) in 39 cases of serpent ulcer reports favorable results in 20, as compared with only one-third, giving favorable results under older methods of treatment. His best results with the serum were obtained in plastic iritis. But in tuberculous forms it proved worthless. He does not find the "serum E." superior to the original form.

Deuxième paire de nerfs crâniens. (F.) The optic nerves.

Deval, Charles. This ophthalmologist was born at Constantinople, Turkey-in-Europe, in 1806. He studied medicine at the University of Paris, receiving his degree in 1834, and for the next four or five

years studied ophthalmology with Sichel. In 1839 he began to practice for himself. Though a skilful surgeon, he would very seldom operate, believing that surgery should be regarded in almost every case merely as a last resort. He had a large practice, but died poor, April 9, 1862.

In addition to numerous articles, he wrote the following:

1. *Chirurgie Oculaire ou Traité des Opérations Chirurgicals que se Pratiquent sur l'Oeil et ses Annexes.* (Pp. 739, Paris, 1844.) This was the second work in French to be devoted to ocular surgery exclusively. The first was Pollier's "*Course of Ophthalmic Operations.*"

2. *Traité d'Amaurose.* (Paris, 1851. Supplement thereto, Paris, 1855.)

3. *Traité Théorique et Pratique des Maladies des Yeux.* (Paris, 1862, pp. 1056, numerous illustrations.)—(T. H. S.)

Developer. A chemical bath for developing a photograph.

Development. In *photography,* the process of rendering the latest image visible. In *physiology,* the prenatal growth of the embryo.

Development of operative skill in the ophthalmic surgeon. This important matter is discussed in extenso under the major heading, **Operative skill in ophthalmic surgery.**

Development of the human eye. OCULAR EMBRYOLOGY. INTRAUTERINE GROWTH OF THE HUMAN EYE. A study of the embryology of the human eye should include the embryology of the head organs in general, the primary development of the optic vesicle, the lens "anlage" (or first indication of the crystalline body), the formation of the optic cup, the growth of the hyaloid artery, the early differentiation of the lens, the tunica lentis vasculosa and, finally, the early differentiation of the primary components of the adult eye. These subjects will, accordingly, be discussed in the order named.

[As Ryder (*System of Diseases of the Eye,* Vol. I, p. 8) long ago observed, the *mammalian embryo* is developed from an egg which at first represents morphologically a single cell. In the course of its development, the substance of the egg divides by means of what is known as indirect or karyokinetic cell-division into two, these two into four, these four into eight cells, and so on, until a globular cell-aggregate is formed. Within this cell aggregate a cavity, the blastocele, is soon developed, filled with fluid, surrounded by a cellular wall composed of the cells resulting from the repeated division of the original germ-cell as mentioned above. This spherical cellular wall is essentially an epithelium. The germ is now a hollow globe, known in mammalian embryology as the blastodermic vesicle, the walls of which are constituted by the products of the segmentation

of the original egg-cell. At one side of this hollow germ the epithelial wall becomes thicker, owing to the manner in which certain cells of its wall proliferate into its cavity. The thickening or area thus marked out soon becomes oval in outline, and constitutes the germinal area from which the embryo is differentiated, together with its developing amnion. This epithelial area of the globular germ of mammals, from which the embryo is developed, is sometimes spoken of as the embryonic area of the blastoderm. It very early becomes split up into the three so-called primary germ-layers. Of these the outer, or ectoderm, is the first to appear, after which the entoderm, or innermost, is formed; while the third layer, or mesoderm, appears last of all between the two first-named. All the structures of the body are developed from the three primary germ-layers of the embryo, viz., ectoderm, mesoderm, and entoderm, of which the first is uppermost and outermost, the second intermediate, and the last lowermost or deepest in position. These three layers are also sometimes spoken of as epiblast, mesoblast, and hypoblast. From the ectoderm, or epiblast, the epidermis, sensory epithelia of the sense-organs, brain, cord, nerves, hair, nails, and superficial dermal glandular structures, the enamel of the teeth, oral epithelium and glands, and epithelium of the nasal chamber are formed. From the mesoderm, or mesoblast, the muscles, bones, cartilages, connective and adipose tissues, heart, blood- and lymph-vessels, blood- and lymph-corpuscles are formed. The entoderm, or hypoblast, gives rise to the epithelium of the alimentary canal and of the lungs, to the secretory cells, ducts, and alveoli of the glandular appendages of the alimentary canal, such as the liver, pancreas, etc., while the smooth muscular fibres of the walls of the alimentary canal and the vascular, adenoid, and connective tissues generally, of its appendages are of mesodermic origin.

All the parts of the eye are developed from but two of the three primary germ-layers. Only the ectoderm, or epiblast, and the mesoderm, or mesoblast, take any part in the building up of this important sense-organ; the entoderm or hypoblast is entirely excluded. The lens, retina, optic nerve, pigmented choroidal epithelium; the epithelia of the conjunctiva, cornea, third eyelid; the ocular nerves, the blastema of the nasal duct, the lachrymal ducts and glands, the Meibomian glands, and the eyelashes, arise from the ectoderm. The muscles, vessels, supra-choroid, sclerotic, the deeper layer or corium of the cornea, the anterior layers, vessels, and muscles, the iris, the humors of the eye, and the bones of the orbit, arise from the

mesoderm. The adjacent and associated nareal structures arise partly from the ectoderm and partly from the mesoderm.—Ed.]

DEVELOPMENT OF THE OPTIC VESICLE.

In early embryos, measuring 1.3 mm. or less, a mediam longitudinal groove along the axis, known as the medullary groove, appears. There soon developes a longitudinal ridge on either side of this groove, forming the medullary folds and outlining the primary neurenteric canal. Coincident with the growth of the embryo, these folds thicken and incline toward the center until they finally meet at their apices. The ectoderm then unites and there results a closed tube, the medullary canal, which with its walls eventually develops into the main portions of the central nervous system. This fusion does not occur uniformly and simultaneously along the entire length of the canal, but first appears at what corresponds to the neck region of the adult and then proceeds irregularly both anteriorly and posteriorly.

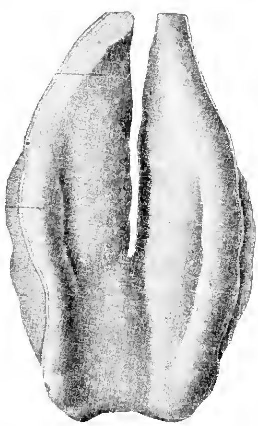


Fig. 1.—Medullary Canal and Ocular Groove. (Bach and Seefelder.)

The enlargement of the anterior portion of the medullary canal is not uniform and, as a result, the brain region early becomes divided into three primary vesicles. Upon each side of the anterior vesicle an evagination appears at a level which corresponds to the junction of the dorsal and the ventral zones. This occurs between the fifth and eighth day. These evaginations, directed first upward and backward, are not spherical, but resemble mounds with their long axes parallel to that of the medullary canal. (Fig. I.) The cavity of the groove, known as the *ocular groove,* is continuous with that of the canal and becomes constricted off only at a considerably later date.

As the lateral ends of the medullary plate close upon the median line, the ocular grooves assume a more lateral and then dorso-lateral posi-

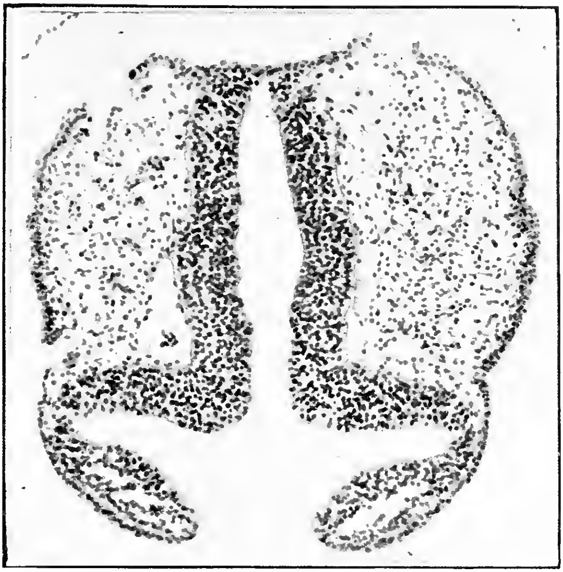


Fig. 2.—Frontal Section Through a Three Millimeter Embryo, Showing Early Optic Evaginations. (Tandler.)

tion. (Fig. II.) This change of position does not occur in the invertebrates and therein is found the explanation of their comparative

Fig. 3.—Optic Evaginations. (His.)

retinal inversion. (Lange.) Within the next ten days, there is a rapid growth of the cells of the ocular groove by mitosis and the mound-shape

is soon changed to spherical, but there is still a pedunculated connection with the walls of the medullary canal. In this stage of development, the ocular anlage is termed the *optic vesicle* and the hollow space it encloses, the *optic ventricle*. The latter is still in free communication with the medullary canal. (Fig. III.)

These primary optic vesicles soon come into apposition with the dorsal walls of the medullary canal at the side of the head. This is coincident with a thickening of the underlying ectoderm as well as of the distal wall of the vesicle. A thin layer of mesoderm has, by this time, grown in and completely separated the overlying external ectoderm

Fig. 4.—Cross Section of Primary Optic Vesicle. (Bach and Seefelder.) *ek*, Ectoderm; *mes*, mesoderm; *l*, lens plate; *au*, optic vesicle; *st*, optic stalk.

from the original ectodermal walls of the primary optic vesicle. The early advent of this mesoderm is characteristic of mammalian development in contrast to other forms of animal life and allows of a later, more complete, differentiation of the tissues. The cells send out runners which unite to form a visible network of protoplasmic threads. By this time, the communication between the optic ventricles and the medullary canal has become more constricted (Fig. IV.). The thickening of the external ectodermal layer of the distal wall, previously referred to and clearly seen in Fig. IV, forms the primary anlage of the *crystalline lens*. This begins at about the middle of the third week and marks the beginning of the next important development, the formation of the *optic cup*.

At about the beginning of the fourth week, the lens ectoderm, which is now rather thick, rapidly becomes depressed. In consequence, the outer wall of the optic vesicle is pushed inward until the inner and outer walls come into apposition. There is thus formed a double-walled

cup, *the optic cup*, lined externally and internally with ectodermal tissue and surrounded by mesoderm. In the mouth of the cup is the rapidly developing lens. (Fig. V.) The edges of the cup assume a rather

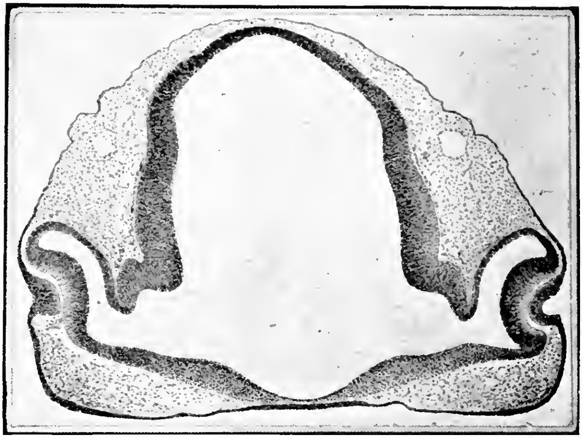


Fig. 5.—Section Through a 5.8 Millimeter Embryo, Showing Lenticular Groove and Ingrowth of Mesoderm. (Grosser.)

regular contour although the ectodermal walls thicken rapidly. Coincident with the cup formation is a gradual individualization of the primary lens anlage. The thickening of the ectodermal lenticular plate

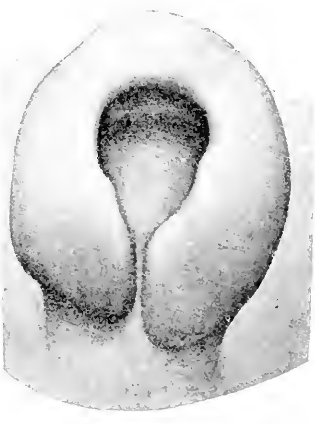


Fig. 6.—Plastic Model of the Optic Cup of a Seven Millimeter Embryo. (Bach and Seefelder.)

and the ectodermal invagination which develops into the optic cup occur simultaneously during the fourth week; but the lens proliferation proceeds more rapidly from this point on so that the lens soon

assumes the contour of an irregular vesicle, lying in the mouth of the optic cup. (Fig. VI.) Henceforth, the lens and optic cup proceed to develop more or less independently.

The cup formation, however, is not perfect, for the invagination extends inwardly onto the posterior surface of the optic stalk and produces there a defect in the ventral wall of the cup. This is first in the form of a longitudinal groove and deepens to form a true fissure, known as the *choroidal fissure.* It does not assume the same depth of invagination as the optic cup proper, but remains shallow, espe-

Fig. 7.—Section Through Anterior Portion of Optic Stalk, Showing the Choroidal Fissure filled with Mesoderm. (Bach and Seefelder.)
ah, Arteria hyaloidea; *st,* optic stalk.

cially at the basal end of the stalk. Before the middle of the fifth week, this fissure has become filled by an ingrowth of mesoderm from the surrounding tissue. (Fig. VII.) Accompanying the mesoderm is an artery, the *arteria hyaloidea.* This is a branch or outshoot from the internal carotid artery, which is the continuation anteriorly of the main aortic trunk, the primary longitudinal vessel. The mesoderm surrounding the hyaloid artery is a continuation of the mesoderm around the internal carotid. (Fig. VIII.) As soon as the artery reaches the floor of the optic cup, it rapidly divides and soon encircles the lens.

As soon as the hyaloid artery is well advanced into the choroidal fissure (about the beginning of the sixth week), the lips of the fissure begin to approach each other and gradually fuse. The union takes place first in the middle of the stalk and then proceeds in both direc-

tions. (v. Szily and Seefelder.) The last to close are the lower ends of the fissure, i. e., the ends next to the main body of the embryo. This process naturally constricts off the mesoderm surrounding the

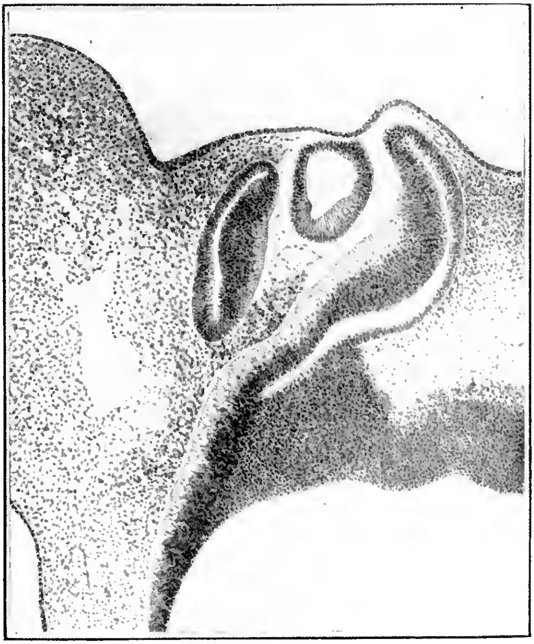


Fig. 8.—Eccentric Section Through an Eight Millimeter Embryo, Showing Choroidal Fissure and Ingrowth of Mesoderm. (Grosser.)

Fig. 9.—Plastic Model of Optic Cup and Closed Choroidal Fissure of an 11.25 Millimeter Embryo. (Bach and Seefelder.)

hyaloid artery, so that the mesoderm eventually comes to lie free in the former ventricle of the optic stalk. The ectodermal layers of the two lips of the stalk undergo a protoplasmic union by proliferation of the cells of both edges. The closure of the fissure occupies about one week, and thus the optic cup cannot be called a perfect cup until the middle of the sixth week or slightly later. (Fig. IX.)

In the meantime the lens anlage has been undergoing changes, the rapidity of which is probably due to the rich vascularization from the hyaloid artery. As we have seen, the ectodermal thickening,

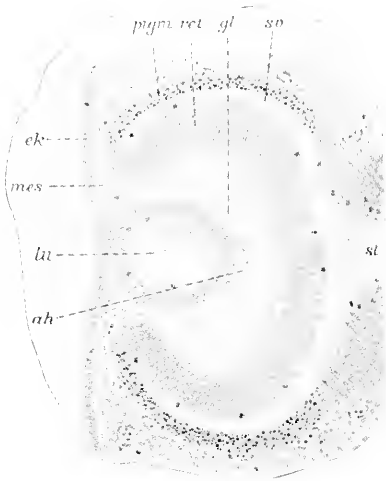


Fig. 10.—Constriction of Lens Vesicle. Section of Entire Ocular Anlage; Embryo 8 Millimeters Long. (Bach and Seefelder.)
ek, Ectoderm; *mes*, mesoderm; *lu*, lumen of lens vesicle; *pigm*, pigment epithelium; *ret*, retinal epithelium; *gl*, vitreous; *sv*, optic ventricle; *st*, optic stalk; *ah*, arteria hyaloidea.

forming the lens, is coincident with the formation of the optic cup and lies in the mouth of it.. The lens continues to become thicker and there soon appears a concavity in its surface, *the lenticular groove*. This is rapidly deepened by a proliferation of the ectodermal cells along its edges which soon unite to form the *lens vesicle*. Thus we have a hollow ectodermal structure, the lens vesicle, lying within a hollow ectodermal cup, the optic cup. (Fig. X.) The constriction of the lens stalk (if it may so be called) and its subsequent separation from the overlying ectoderm occurs much in the same way as the otocyst is constricted off. The overlying mesoderm forces its way into the optic cup between the lining ectoderm and the lenticular ectoderm until it unites with the mesoderm that has entered the optic cup

through the choroidal fissure. The lens vesicle is thus floating freely in a sea of mesoderm and has entirely severed all ectodermal connections. (Fig. XI.) From this point on the development of the lens must be considered separately.

The recent work of Pagenstecher in producing lenticular anomalies by feeding B-naphthalin to the parent has shown that the lens is thus affected at about the time of its constriction off from the optic cup. These anomalies, for the nature of which I would refer the

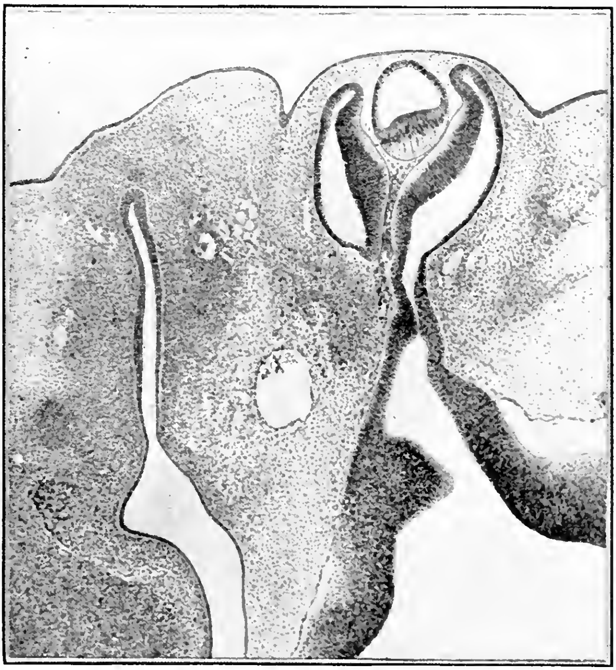


Fig. 11.—Section Through a 13.4 Millimeter Embryo. (Grosser.)

reader to the original article, would seem to be due to malformations in the lenticular nuclei. v. Szily corroborates this view.

The mesodermal tissue separating the lens vesicle from the ectodermal lining of the optic cup is continuous through the mouth of the cup with the mesoderm surrounding the entire cup. The whole is, of course, still covered with the thin layer of surface ectoderm. (Fig. X.) The growth of the ectodermal mouth of the cup is slightly more rapid than that of the lens vesicle and hence the latter soon comes to lie behind the margins of the optic cup proper. These close upon themselves over the lens until there merely remains a small

opening between the lips of the cup, filled with mesoderm and known in adult life as the pupil. This development is hindered in some cases by the anastomosis of the hyaloid artery with the ring artery or its branches and there results the defect in the edges of the pupil known as coloboma iridis. The mesoderm covering and filling the pupillary area soon shows a split into two parts, the thinner posterior layer forming the vascular covering over the iris and anterior portion of the lens, the *tunica lentis vasculosa;* while the thicker external layer forms the primary anlage of the *cornea.* The cavity between these layers represents the *anterior chamber* of the adult eye.

Following the splitting of the mesenchyme, which invades the mouth of the optic cup, into the vascular tunic of the lens and iris and into the cornea, a rather close union occurs between the anterior mesodermal layer and the overlying ectoderm. This latter always retains something of its embryonal character even after its complete differentiation into adult corneal epithelium and never develops a stratum corneum, as does the other ectodermal developmental product, the skin. The mesodermal portion of the cornea rapidly becomes thicker, and its cells arrange themselves into three distinct forms; a simple fusion forming a thin, homogenous membrane underneath the surface ectoderm (Bowmann's membrane); a rather uniform lamellar as well as fibrous arrangement forming the corneal stratum proper and the ligamentum pectinatum iridis (these fibres are somewhat separated and the cavities thus formed constitute the spaces of Fontana); and a continuous endothelial lining along the inner surface of the cornea (Descemet's membrane). In the peripheral part of the cornea the fusion between the ectoderm and the mesoderm is of a looser character, and these two structures together later differentiate into the conjunctiva.

The primary formation of the *choroid* and *sclera* is probably one of the simplest that occurs in the entire development of the eye. As we have seen, the space surrounding the optic cup and under the overlying ectoderm is filled with a rather loose mesodermal tissue. At about the same period as the beginning differentiation of the cornea, this mesodermal tissue undergoes a contraction and begins to separate into two layers. The inner layer is rather loose in character and consequently becomes highly vascularized. This ultimately forms the *choroid.* In the outer layer there is the greatest contraction and fibrous formation, so that there ultimately results a dense, firm tissue surrounding the optic cup. This is the *sclera.* Its anterior fibres merge invisibly into the corneal fibres and during the early

stages of embryonic life are identical in structure with the fibres of the middle mesodermal layer of the cornea.

To return to the optic cup. The posterior ectoderm or internal portion of the bulb is represented by the outer ectodermal wall of the optic cup; while the anterior ectoderm or external portion of the bulb has formed the inner lining ectodermal wall of the cup. This is due to the invagination of the primary optic vesicle. (Fig. XII.)

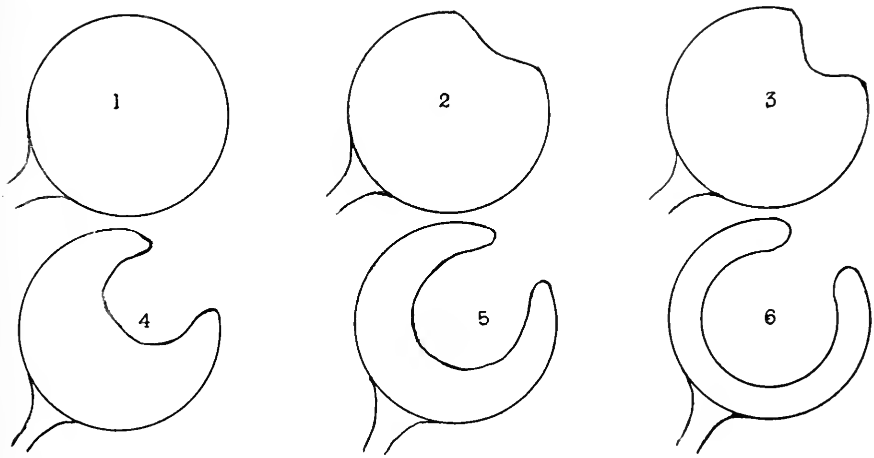


Fig. 12.—Schematic Diagram Representing Process of Invagination of the Optic Ectoderm, Resulting in the Double-Walled Ectodermal Cup.

The differentiation and growth of these two ectodermal layers, now in apposition, proceeds along similar lines up to a certain stage. Then the outer layer increases in size and becomes the seat of a dark pigmentation. This begins at the posterior pole of the eye and develops rapidly anteriorly. But the site of fusion of the lips of the primary choroidal fissure, where the optic stalk joins the optic cup, presents a slight delay and the pigmentation is well advanced toward the equator before there is any pigment deposit at this point. This pigmented layer forms the *pigment layer of the retina* or, more properly speaking, of the optic cup. The inner layer, formed by the invagination of the optic bulb, remains much thicker and even increases in thickness in its proximal portions. This is termed the *retinal layer of the optic cup.* Thus it is that from the ectodermal walls of the optic cup, the retina, ciliary body, and iris are formed, but their differentiation as individual elements must be considered separately.

We have traced the growth of the optic cup until its anterior ecto-

dermal walls have come to lie in front of the lens, with the exception of the space known as the pupillary area. We have also followed the growth of the mesoderm which has forced its way in between the optic cup and the overlying ectoderm, and have seen how this mesoderm has undergone a split (the anterior chamber) the anterior portion of which is differentiating into cornea while the posterior portion lies over the walls of the optic cup. It also protrudes into the mouth of the cup and joins with the tunica lentis vasculosa. (Figs. XIII and XIV.) Coincident with the adhesion of this posterior layer

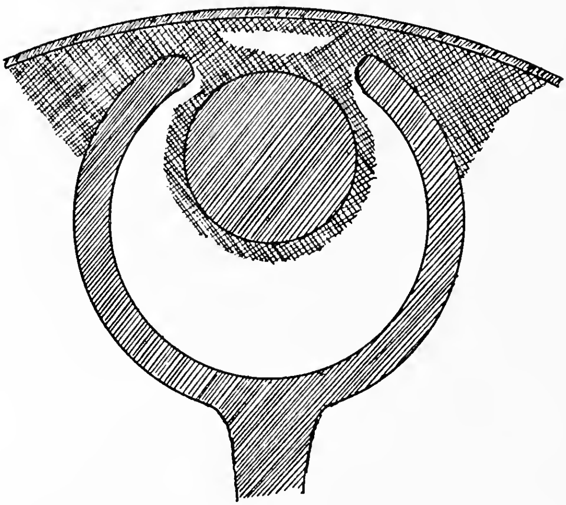


Fig. 13.—Schematic Diagram, Representing the Mesoderm, that Eventually Differentiates to Form the Anterior Chamber, Cornea, Iris and Tunica Lentis Vasculosa.

of mesoderm and the walls of the cup, there occurs a thinning of the anterior portion of the pigment layer and retinal layer. (Fig. XV.) The latter loses its characteristics, becomes merely one or two cell layers deep and as heavily pigmented as the pigment layer proper. This also becomes thinner and eventually the two layers fuse so that their individual identity becomes lost. The fusion of these two layers forms the *retinal or pigment layer of the iris and ciliary body.* At about the 35th day this pigmented layer in the region of the ciliary body becomes thrown into radiating folds, as though the growth of this portion were more rapid than that of the surrounding tissue. As the sclera is fairly well developed by this time, these folds are forced toward the inside of the developing eye. (Fig. XVI.) Although

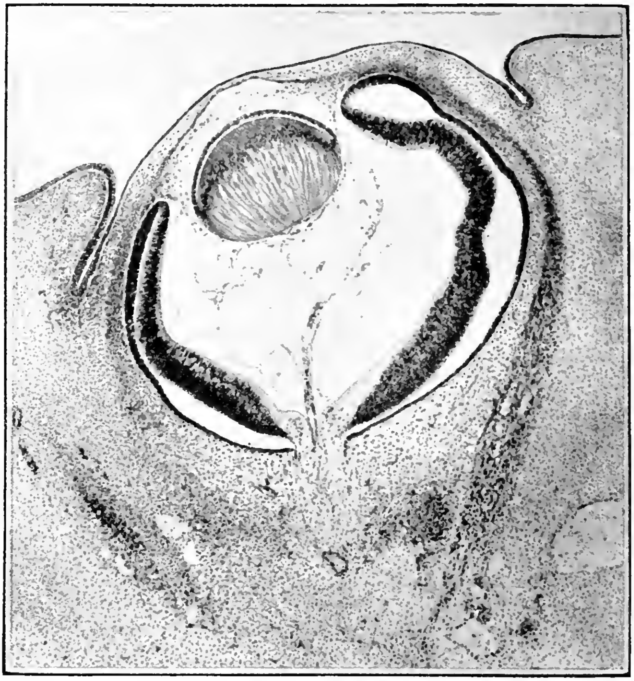


Fig. 14.—Section Through a 22.8 Millimeter Embryo. (Grosser.)

Fig. 15.—Cross Section of Optic Anlage in Embryo 11.3 Millimeters Long. Beginning differentiation of iris and ciliary body. (Bach and Seefelder.)

these folds occur primarily in the region of the iris as well as of the ciliary body, by the end of the fifth month, they are limited to the ciliary region alone and the iris pigment layer has assumed its mature contour. The posterior layer of mesoderm, in apposition with this developing ectoderm, has been making similar strides, and we find differentiation of this tissue into the *stroma of the iris and ciliary body.* As the radiating folds of the ciliary body develop, mesodermal

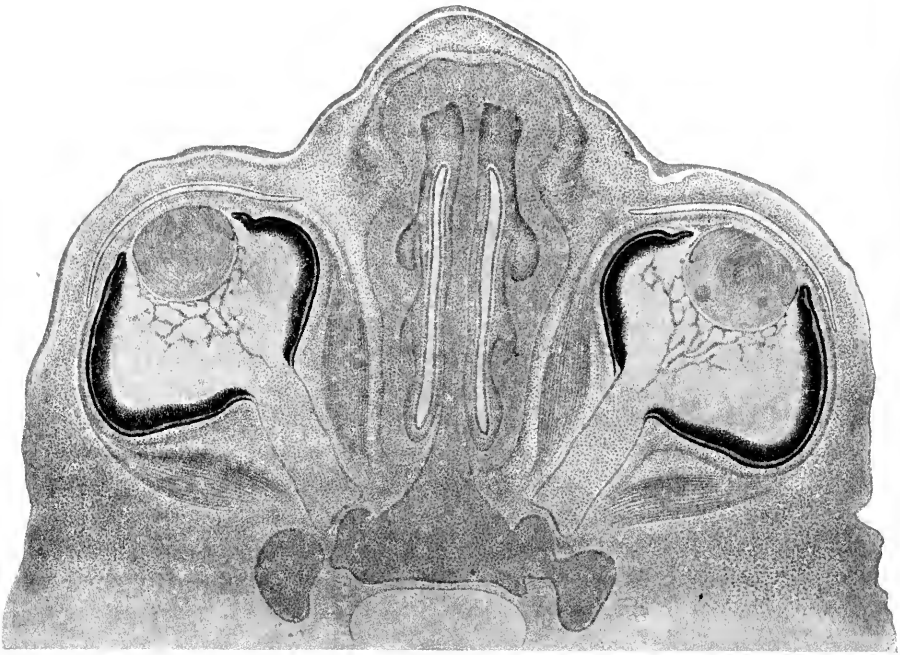


Fig. 16.—Cross Section of Optic Anlage of Embryo About 45 Millimeters Long. Primary ciliary folds. (Bach and Seefelder.)

lamellæ project themselves into the spaces thus formed and become inseparably associated with the ectoderm in growth. The mesodermal portion of the iris keeps pace in its development, but assumes a rather looser, less laminated character. The tunica lentis vasculosa is continuous with the iris stroma and remains so until the lens has completed its period of active growth. This occurs during the seventh month. The sphincter and dilator fibres of the iris musculature are of ectodermal origin, whereas the ciliary muscle develops from the mesoderm.

The differentiation of the truly retinal portions of the optic cup keeps pace with the anterior aspects. We have seen the beginning

pigmentation of the pigment layer and the enormous thickening of the retinal layer as far forward as the ciliary region. Here the marked transition from the thick posterior to the thin anterior parts of the retinal layer remains manifest in adult life in the form of the ora serrata. Soon after the increase in size in the retinal layer has occurred, this becomes differentiated into two strata; an inner, non-nucleated, thin layer and an outer, thick layer with numerous nuclei. (Compare Fig. XIV.) Through the first of these two layers develop the *transparent nerve-fibre* of the retina, which in turn develops from the *ganglion cell layer*. This is a differential product of the denser inner layer and is the basis from which the remaining retinal components are evolved. (Fig. XVII.) The finer differentiation of the retina must be dealt with separately.

The origin of the *vitreous* is still a disputed point. The view of its ectodermal genesis was fathered by von Lenhossek and now probably has more adherents than the opposing views. Schöler and Virchow first attributed the vitreous to pure mesodermal origin, and their original ideas are still upheld by many. Again the theory of combined ectodermal and mesodermal origin is held by some as correct; others regard the vitreous merely as a transudate from the arteria hyaloidea. In brief, the ectodermal theory holds that the small, bullet-shaped bodies (von Lenhossek bodies) found in the inner layer of the retina, and which later develop into the Müller neuroglia fibres, send out fine radiating processes into the vitreous chamber (von Lenhossek fibres). These also arise from the posterior ectodermal surface of the lens and there results a very fine ectodermal network of fibres. Toward the anterior portion of the eye these fibres are supposed to develop in part into the fibres of the zonule of Zinn. The mesodermal theory claims that the vitreous is developed from the mesoderm that accompanies the hyaloid artery into the optic stalk. It presupposes that the growth of this mesoderm does not stop at the head of the optic nerve, but continues on, forming the vitreous network and fusing with the tunica lentis vasculosa. Although the evidence in favor of the ectodermal origin of the vitreous would seem to be preponderating, still both theories will be fully discussed under development of the vitreous.

The *optic nerve* is formed by the axis cylinder processes of the ganglion cells of the retina which gradually grow into the original optic stalk. After this has become partially obliterated by the ingrowth of the arteria hyaloidea and subsequent closure of the cavity of the distal portion following the closure of the choroidal fissure, the ventral and posterior walls of the stalk are brought into continuity

with the retinal layer of the optic cup. Thus the axis cylinder processes of the ganglion cells can easily pass along these walls. After the stalk has become filled with these axis cylinder fibres, the nuclei lining the stalk proliferate to form the supporting neuroglia cells of the optic nerve proper. Thus it can be seen that the so-called optic nerve is not a true cranial nerve, nor in fact a nerve at all, but merely an association path of the central nervous system, correspond-

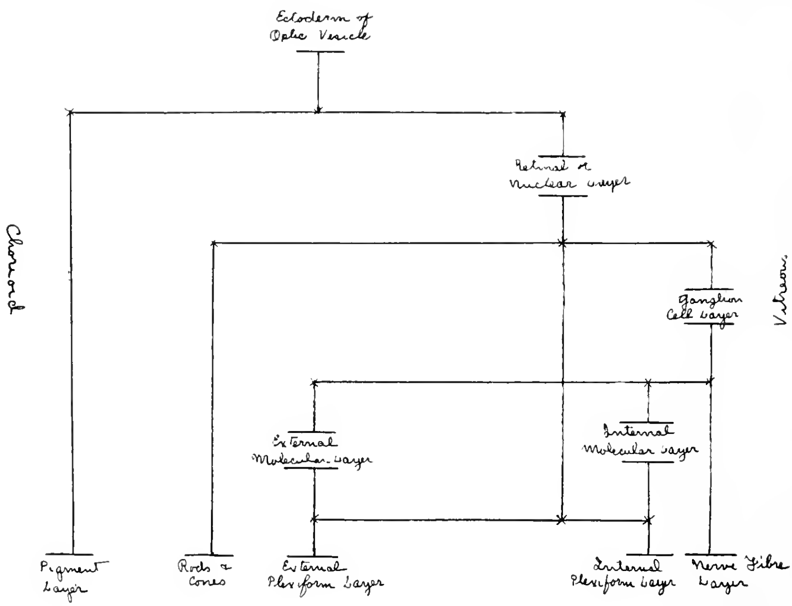


Fig. 17.—Schematic Diagram of Development of Retinal Layers.

ing histogenetically with the other association paths. For the optic nerve is not an outgrowth from the brain to its terminus, but rather an ingrowth from the eye into the brain. The hyaloid artery is recognized in adult life as the arteria centralis retinæ. However, in the embryo, it is not terminal in the retina as the central artery is in adult life, but continues its path through the vitreous. Its degeneration begins during the third month, and by the end of the ninth month the artery has entirely disappeared except in some few anomalies where its stump can be seen waving to and fro in the vitreous humor. In the beginning the retinal arteries are merely lateral and not terminal branches of the main arterial trunk.

DEVELOPMENT OF THE CORNEA.

Our present knowledge of the development of the cornea must be dated from the researches of von Lenhossek and van Peès, who first elucidated the problem of the so-called "*anterior vitreous.*" Von Szily continued the work which was utilized by Knape in his further investigation. Although the appellation "anterior vitreous" is possibly not the best term that could be employed, still usage has so inseparably connected it with the early corneal development that we shall continue to use it. As the development of the mature corneal tissues is dependent upon this embryological truss tissue, we must first discuss its genesis.

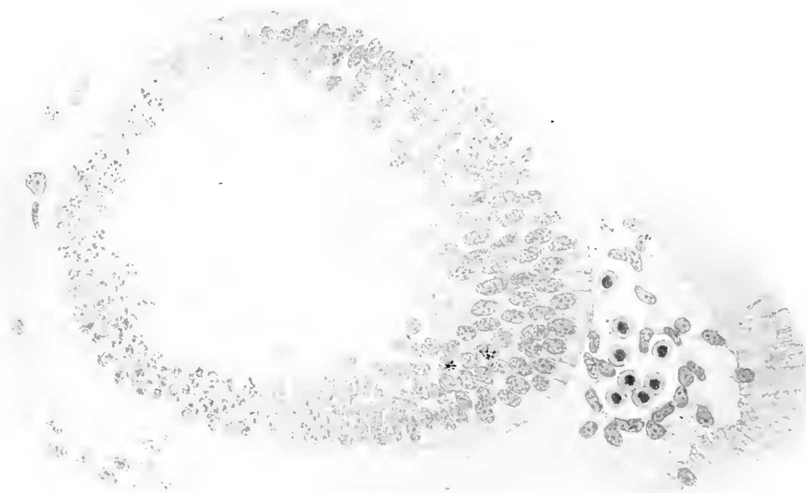


Fig. 18.—Lens Vesicle of an Eight Millimeter Embryo. (Bach and Seefelder.) This shows the fibrillæ of the anterior vitreous originating from the von Lenhossék bodies of the posterior wall of the lens.

Development of the anterior vitreous. The anterior vitreous first makes its appearance during the end of the fourth week; that is, in an embryo of about 8 mm. in length. This is during the period when the lens vesicle is beginning to separate from the layer of ectoderm covering the optic cup. High magnification and special stains will show that the space between the lips of the optic cup, the lens vesicle, surrounding mesoderm, and overlying ectoderm, is filled with a delicate fibrillar network. The fibrillæ of this tissue can be traced to

the von Lenhossek bodies that are found in the surrounding ectodermal structures. (Fig. XVIII.) For the most part, these fibrillæ seem to be protoplasmic outgrowths through an intact cell membrane, but occasionally we find individual cells lying superficially with a broad base and free protruding end, which breaks up into flagellæ-like fibrils. These arise from the lens as well as the surrounding ectodermal structures.

The transition from anterior vitreous to vitreous proper is such a gradual one that a sharp line of demarcation cannot be said to exist.

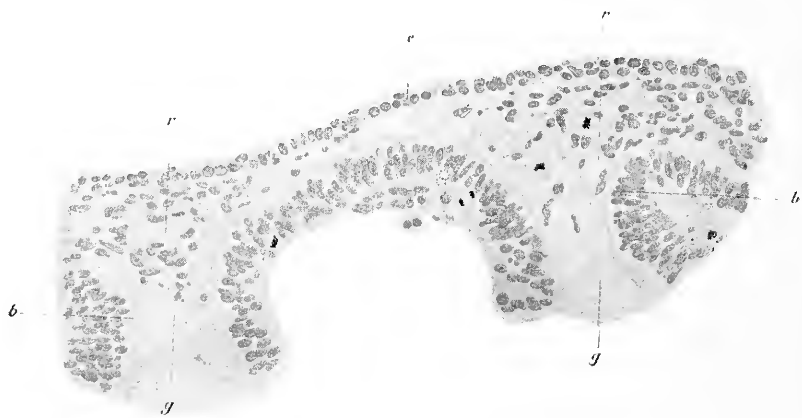


Fig. 19.—Anterior Section of the Optic Anlage of a 12.7 Millimeter Embryo, Showing the Advent of Mesoderm Between the Optic Cup and the Overlying Ectoderm. (Bach and Seefelder.)
e, Ectoderm; *g*, vitreous; *r*, ring vessels; *b*, edge of optic cup; *l*, lens.

As there is no essential morphological difference between these two structures up to this stage of development, the term "anterior vitreous" would seem to be justified. The mesoderm between the edges of the optic cup and the overlying ectoderm merges invisibly with the fibres of this embryonic truss tissue, as is the case with the ring vessels. However, in some of the embryos reported (Seefelder) this mesoderm is nearly lacking, and the space it should occupy is filled with anterior vitreous, which is in apposition on one side with the overlying ectoderm and on the other with the ectoderm of the optic cup. As a result of this anomalous and very rare condition, we are further justified in attributing the origin of this tissue to ectodermal sources. For here the anterior vitreous is primarily not in contact with any mesodermal tissue.

In describing the development of the cornea it is impossible, until a certain stage has been reached, to describe the formation of the indi-

vidual layers. Consequently, the plan adopted by Bach and Seefelder in their inestimable *Atlas* offers the best solution of the problem. Therefore, the next stage in the development of the cornea to be described is the advent of mesoderm between the optic cup and the surface ectoderm. This was first seen by Seefelder in an embryo of 12.7 mm. length (5 to 6 weeks) and is most clearly shown by Fig. XIX. From the mesoderm separating the optic cup from the surface ectoderm, individual cells wander into the space occupied by the anterior vitreous, anterior to the pupillary area. These cells do not show any

Fig. 20.—Corneal Mesoderm in a 14.5 Millimeter Embryo. (Bach and Seefelder.) *e*, Ectoderm; *g*, vitreous; *r*, ring vessels; *b*, edge of optic cup; *l*, lens.

tendency toward definite arrangement, but lie irregularly in the meshwork of the anterior vitreous. (Compare Fig. XI.) A slight degree of mitotic reproduction is found to be present. Gradually the number of these cells increases and a tendency toward regular arrangement can be seen. A section from an embryo but slightly larger (Fig. XX) shows that the mesodermal cells, which can be recognized by their similarity to the cells of the surrounding mesoderm, have assumed a two cell-layer deep formation. They are not close together and there can still be seen many fibrillæ of the anterior vitreous between them. These fibrillæ are no longer connected with the overlying ectoderm and only occasionally can a connection with the cells of the lens vesicle be discovered. The mesodermal cells have also begun to wander over the edges of the optic cup and invade the vitreous proper. Here, as well as in the anterior vitreous, there is an

imperceptible merging of the ectodermal and mesodermal elements. The lens has by this time reached a stage of development where its anterior capsule is beginning to be differentiated, and the corneal epithelium is about two cell-layers deep. As yet there is no Bowman's or Descemet's membrane even remotely visible, and it is in this form that the cornea of the human embryo remains for a considerable length of time. Now we can begin to consider the development of individual elements of the cornea separately, and this had best be done from the position, aspect forward.

The *Descemetian endothelium* first makes its appearance in embryos of about 20 mm. length and there seems to be no doubt that it arises as a differential product of the anterior vitreous. The trans-

Fig. 21.—Early Corneal Endothelium in a Twenty Millimeter Embryo. (Bach and Seefelder.)
ep, Epithelium; *g*, ground substance; *en*, endothelium.

formation of the fibrillar-like cells of the anterior vitreous into the well-formed endothelial cells lining the posterior surface of the cornea is very gradual, but the various stages are not clearly defined. The first appearance in a single layer of well-developed endothelium, interspersed with many spaces not more than one cell in width. This layer lies very near the anterior surface of the cornea and in the center is separated from it merely by a thin layer of a collagenous substance, showing but few fibrillæ. In the earlier stages, not even mesodermal cells separate the anterior and posterior corneal layers in the middle (Fig. XXI), but in the periphery there are several illy-defined layers of mesoderm. Here the endothelium passes gradually into the surrounding mesoderm, which eventually organizes to form the sclera and choroid.

By the time the embryo has attained a length of from 30 to 35 mm., the endothelium has undergone sufficient mitotic division so that the aforementioned spaces are fairly-well filled in. Mesodermal cells have grown into the collagenous tissne, and we can perceive the resemblance to the adult cornea. Mitosis continues until a length of from 65 to 70 mm. has been reached, when the Descemetian endothelium has at-

tained its mature character. Now we have an unbroken single layer of endothelial cells lining the posterior surface of the cornea, reaching from chamber-angle to chamber-angle and separated from the surface ectoderm by the various corneal tissues. Mitotic figures have been observed, however, as late as the fifth month.

Descemet's membrane. The exact genesis of Descemet's membrane proper is still somewhat in question, but the majority of authors lean toward its endothelial origin. This view is based more upon the clinical fact that endothelium is capable of producing a transparent membrane (Glasshaut) than upon pure embryological data. Refor-

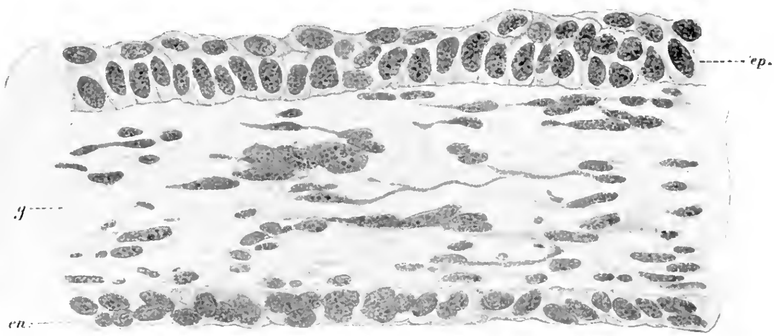


Fig. 22.—Periphery of the Cornea in a Twenty-four Millimeter Embryo. (Bach and Seefelder.)
ep, Epithelium; *g,* ground substance; *en,* endothelium.

mation of the Descemetian membrane after corneal rupture proceeds from the endothelium. The date of formation of this membrane is also in doubt. Treacher Collins places it during the tenth week, while Fritz does not believe in its presence until the sixth month has elapsed. In an embryo of about 100 mm. (about 3½ months) Seefelder found the first intimation of a Descemetian membrane while the next younger embryo of about 65 mm. length, or about 2¾ months in age, showed no traces. As we have seen, the Descemetian endothelium is completed at an age corresponding to about 70 mm. of length, and then the membrane proper is probably formed from the underlying endothelium as a basal membrane. There has been nothing found to show that it has any fibrillar character. At first and during the early fetal life, the transparent membrane remains very thin and attains its relative size only in extra-uterine life. Its differentiation from the corneal stroma by means of the simpler stains is possible only after the fifth month of fetal life.

Ground substance. In embryos of 20 mm. length and slightly less, the corneal substance, between the epithelium and endothelium, is composed almost exclusively of scattered fibres of the anterior vitreous containing a few mesodermal cells, especially in the periphery. (Fig. XXI.) But the character of this tissue soon changes with the advent of the mesoderm. As these cells proliferate by mitotic division, they also send out fibrillæ, similar in composition to the original fibre cells of the anterior vitreous, but different in size and smoothness, as well as possessing a different index of refraction and a peculiar cork-screw shape. Although the two kinds of fibrillæ stain alike, still they can be differentiated at a glance. The very character of their reaction to specific stains shows that they are of a collagenous nature. Thus it is that from the mesodermal cells proper, the ground substance of the cornea, of a fibrous, collagenous nature, is formed.

During the next ten days the cornea increases rapidly in thickness. All of the mesodermal cells show various forms of mitosis, and from most of them can be seen emanating the delicate fibrillæ of the future ground-substance. They have already begun to assume a somewhat laminated arrangement with their long axes parallel to the surface of the cornea. Anterior vitreous fibres have practically disappeared, although here and there a few are still visible. The cornea has now assumed its typical fetal character which, though continually changing, it retains until birth. The stroma is of a loose character and can be microscopically differentiated from the limiting membranes. The posterior part is somewhat denser, contains more cells in close association, as well as more connective tissue. The fibrillæ are more nearly parallel with the corneal surface than are those of the anterior part and lose their connection with the mesodermal cells sooner. Still it is easy to differentiate the homogenous membrane of Descemet from the fibrillar structure lying anterior to it. (Fig. XXII.)

This proliferation gradually progresses and our next marked change can be seen in an embryo of about 65 to 70 mm. in length. Macroscopically the anterior zone of looser character is about four times as thick as the posterior dense zone. The fibrillæ of the latter have lost all connection with their mesodermal cells, lie close together, and have assumed the typical laminated structure of the cornea, parallel to the surface. (Fig. XXIII.) In the anterior zone these characteristics are, to a certain extent, lacking, although the transition from the one zone to the other is a very gradual one. The fibres of the anterior vitreous have entirely disappeared. The relative size of the two zones gradually changes, so that by the beginning of the sixth month the

anterior has lost its loose type, become as dense as the posterior, and the corneal ground-substance presents a uniform appearance.

Elastic fibres. The elastic fibres of the cornea make their appearance toward the end of the third month, but unfortunately there is not a single specimen extant showing their first development. They appear as a somewhat homogenous fibre that reacts blue to the Mallory stain. Most of the fibres are isolated and lie scattered irregularly without regard to the corneal lamination. Some, however, show protoplasmic connection with the corneal cells proper and occasionally one can be found connecting two adjacent cells. For the most part

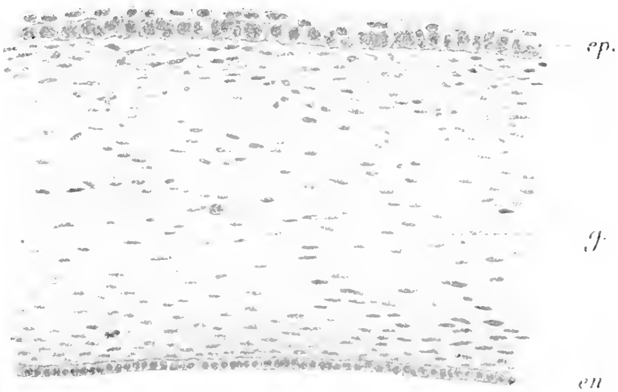


Fig. 23.—Corneal Anlage of a Forty-five Millimeter Embryo. (Bach and Seefelder.)
ep, Epithelium; *g,* ground substance; *en,* endothelium.

the fibres are wavy and end in a sharp point, but some present a hook-like terminus. In the early embryonic life they are more numerous in the posterior corneal layers, corresponding to the denser posterior zone, but as the dense and loose zones lose their characteristics, the elastic fibres become uniformly scattered throughout the cornea, with one exception. Toward the beginning of the seventh month there can be found a rather densely-woven layer of elastic fibres external to the homogenous Descemetian membrane, but absolutely independent thereof. This develops into the layer to which Seefelder gives the name "lamina elastica corneæ."

Bowman's membrane. Of all of the corneal layers, Bowman's membrane is the last to develop. Toward the middle of the fifth month it first makes its appearance in what seems to be a homogenous form. But special stains show that its structure is distinctly fibrillar and that the fibres entering into its composition are very delicate. They

are closely interwoven and form a fine meshwork. The external surface of the membrane is smooth and can be easily differentiated from the basal cells of the overlying epithelium. But the internal surface is irregularly rough and occasionally a connection between the Bowman fibrils and the corneal ground-substance can be detected. (Fig. XXIV.) Thus the origin of Bowman's membrane would seem to be definitely established.

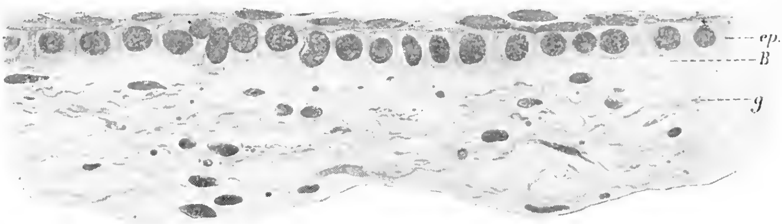


Fig. 24.—Cornea of a Fetus During the First Half of the Fifth Month, Showing the Fibrillar Structure of Bowman's Membrane. (Bach and Seefelder.)
ep, Epithelium; *B*, Bowman's membrane; *g*, ground substance.

During the course of the next month the picture changes radically. The membrane has increased in thickness and has assumed a more regular contour. Even with the Mallory stain, it appears nearly homogenous and its fibrillar character is retained only in isolated areas. (Fig. XXV.) These, however, disappear during the succeeding month,

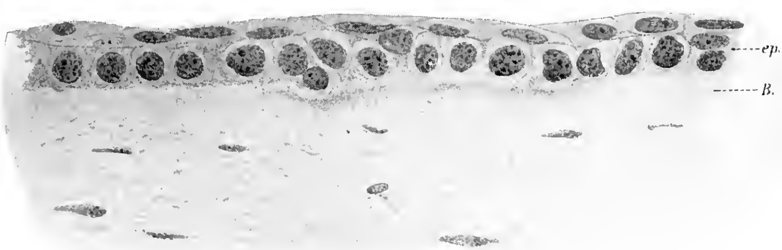


Fig. 25.—Section of Cornea of a Six Months' Old Fetus, Showing Isolated Fibrillar Character of Bowman's Membrane. (Bach and Seefelder.)
ep, Epithelium; *B*, Bowman's membrane.

so that by the seventh month the membrane has a homogenous structure with no adherence to either the corneal epithelium or the corneal ground-substance. Its mature thickness has not been attained yet, and this appears only in extra-uterine life.

Epithelium. The corneal epithelium is merely a continuation of the ectoderm over the surface of the entire embryo. At first this is

a single layer, but during the sixth week it begins to develop into a two-cell layer. This second layer consists of flattened epithelium with large nuclei, the long axis of the cell lying at right angles to the corneal surface. This stage continues until about the sixth month, when individual polyhedral cells make their appearance between the first two layers. The fourth layer develops at about the time of birth and the fifth and sixth, four or five months later. Even up to this time, mitotic figures can be found in the basal cells of the epithelium.

DEVELOPMENT OF THE LENS ZONULE AND VITREOUS.

The lens is purely ectodermal. As previously shown, the ectoderm over the optic vesicle begins to thicken during the third week of

Fig. 26.—Cross Section Through the Head of 4.9 Millimeter Embryo, Showing the Primary Lens Anlage. (Bach and Seefelder.)
ek, Ectoderm; *mes*, mesoderm; *l*, lens plate; *au*, optic vesicle.

embryonic life. This thickening does not proceed from any one definite point, according to the experimental proof of various investigators, but can occur anywhere along the surface. It is of interest to note that Lewis was able to cause the skin (anywhere on a frog's head) to produce lens tissue by implanting embryonic ocular tissue

underneath the skin. As the optic vesicle begins to invaginate to form the optic cup, the lens plate, now composed of the typical ectoderm, plus one additional layer of cells, forms a distinct bulge, both dorsally and ventrally. This extra layer of cells is of the high cylindrical type, so closely crowded together that their nuclei form two irregular rows. Mitotic figures are found only superficially. (Fig. XXVI.) The basal ends of the cells form a perfectly straight line, as v. Lenhossek has pointed out, but occasionally we find a cell at whose basal end there is a rounded nodule. This is drawn out and terminates in a very fine fibril which becomes lost in the mesoderm found between the optic vesicle and the overlying ectoderm.

The invagination of the optic cup proceeds rapidly and the development of the lens plate keeps pace with it. During the course of the

Fig. 27.—Section of the Ectoderm with the Lenticular Groove. (Bach and Seefelder.)

next seven days, three to four additional layers of epithelial cells develop, so that the lens plate now assumes a plano-convex shape. The plane surface is superficial and forms a distinct groove in the overlying ectoderm, the *lenticular groove*. (Fig. XXVII.) The convex surface of the lens plate bulges toward the invaginated opening of the optic cup, but is separated from it by the ingrowing mesoderm. The ectodermal cells forming the lens plate have assumed a more regular contour, although a few of the rounded basal nodules are still to be seen. The fibres originating from these knobs are longer than when first seen and some are forked. Superficially a few irregular, unattached cells are found.

As the development advances, the lens assumes a concavo-convex form. The lenticular groove deepens by a mitotic proliferation of the superficial cells that is less rapid than of the cells on the convex surface. Thus the lenticular plate becomes metamorphosed into the *lenticular sac*, an ectodermal pouch whose walls are a thickened contin-

uation of the surface ectoderm extending into the mouth of the optic cup and surrounded by mesoderm. The cavity of the sac is in free communication with the amnionic cavity through a small opening, the *lenticular pore*. (Fig. XXVIII.) This does not lie centrally in the distal portion, but is more ventral and its walls do not form straight lines, but are interrupted by lateral folds, of which the dorsal is the longer. The loose cells that lay on the plane surface of the plate are now found in various stages of mitosis and degeneration within the cavity of the sac.

Toward the end of the fourth week the walls of the lenticular pore undergo a rapid proliferation and come into apposition, completely clos-

Fig. 28.—Section Through Anterior Optic Anlage of a Six Millimeter Embryo. (Bach and Seefelder.)
The lenticular sac is now an entity and shows a distinct lumen (*lu*).

ing the pouch and transforming it into the *lenticular vesicle*. This is still connected to the superficial epithelium by a dense strand of ectoderm, which represents the union of the walls of the lenticular pore. Communication with the amnionic cavity no longer exists. The vesicle lies fairly well in the mouth of the optic cup and is surrounded by mesoderm. There is a distinct connection with this latter and the vesicular walls by the fibrillæ of the v. Lenhossek nodular cells. Contrary to expectations, the vesicle is not spherical, but has a somewhat pyramidal shape. In the center can still be seen some of the loose cells before mentioned, although they now show various stages of degeneration. (Fig. XXIX.)

Shortly after the formation of the lens vesicle, there can be seen a difference in its walls. The cell layers of the outer or distal half be-

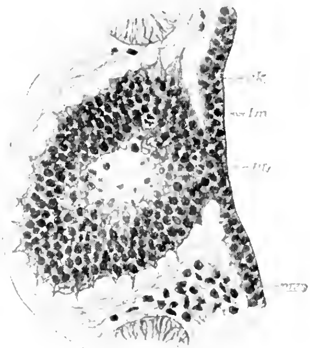


Fig. 29.—Embryo of About 6.5 Millimeter Length and Under High Magnification. Lumen of lens vesicle now empty. (Bach and Seefelder.)
ek, Ectoderm; *lw,* wall of lens vesicle; *lu,* lumen of lens vesicle; *mes,* mesoderm.

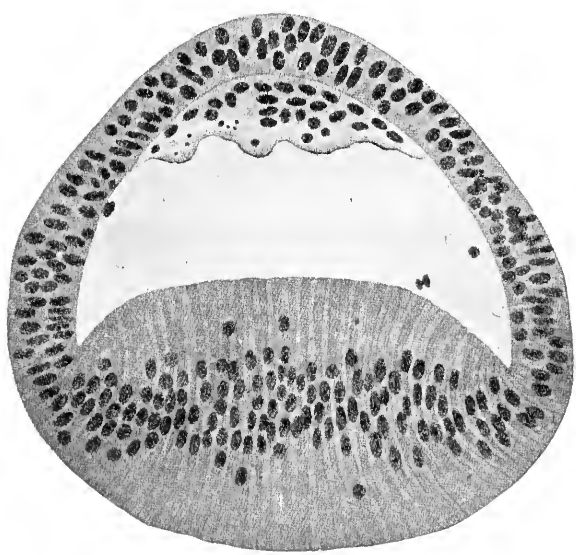


Fig. 30.—Lens Vesicle. (Rabl.)

come thinner and eventually there results but a single layer of cells. This is the anlage of the adult anterior epithelium of the lens. The lens fibres proper arise from the cells of the inner or proximal half,

which proliferate rapidly and form a cushion or knob extending into the lumen of the vesicle. (Compare Fig. XI.) These cells increase prodigiously in length and soon assume the dignity of fibres. Those fibres arising from the middle of the cushion extend in an antero-posterior direction, while the peripheral fibres assume an antero-concave form. With this change in the form of the cells the lens becomes nearly spherical, with a thick posterior or proximal wall and a very thin anterior or distal wall. (Fig. XXX.) This latter wall is thinner in the center and increases in thickness toward the equator. The posterior wall proliferates so rapidly that the cavity of the vesicle

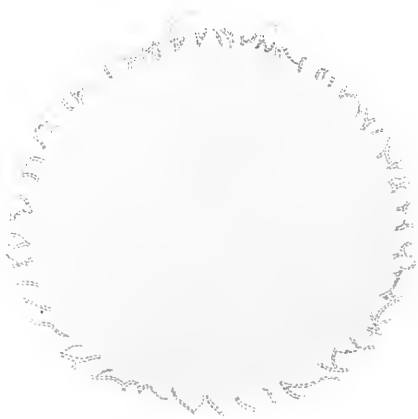


Fig. 31.—Posterior Lens Star in a Fetus 120 Millimeters Long. (Bach and Seefelder.)

soon becomes very small. The loose cells, formerly abundant, now have disappeared entirely, as have the various degenerated cells. As soon as the lens fibres assume their mature form, they cease proliferating and no more mitotic figures can be found. Their increase is merely in length. From this point on the lens proliferates by apposition alone. (Compare Fig. XIV.)

Tandler has shown that as early as the sixth week the lens vesicle becomes filled by the rapid cellular proliferation, so that no intravesicular space longer exists. But the *lens sutures* do not make their appearance until about the beginning of the third month. As we have seen, the lens fibres arise from the posterior wall of the lens vesicle, and as each individual fibre attains its mature form, it no longer produces karyokinetic figures, but grows merely by increasing

its length. Hence the peripheral fibres, being actually older, are longer than the more centrally lying fibres and their peripheral ends overlap the peripheral ends of the central fibres. This overlapping produces a cleft, which lies horizontally, extending from nearly the center of the lens to the posterior wall. This is the first *lens suture.* The anterior or *second suture* lies horizontally also, but in a slightly lower plane than the first and extends toward the anterior wall. The first suture is joined by the *third suture,* which is vertical and slightly inclined anteriorly. This union forms a three-pointed *lens star* and takes place during the fifth month. (Fig. XXXI.) Gradually the

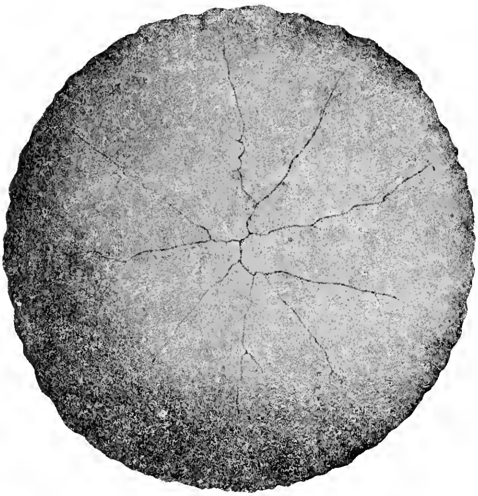


Fig. 32.—Adult Lens. Posterior Surface Showing Lens Star. (Rabl.)

star assumes a six-pointed shape, and during adult life assumes nine or even more points. (Fig. XXXII.)

DEVELOPMENT OF THE ZONULE OF ZINN.

The origin of the zonule of Zinn is still in dispute. One school, headed by v. Lenhossek, believes that these fibres are a differential development of the vitreous and are led to this view by the various developmental stages in the eye of the chick embryo. The other and more plausible view is that these fibres develop from the retinal epithelium. In the zonule region, the membrana limitans interna of the retina is entirely lacking, while it can be traced easily in the rest of the ciliary body and iris region. Hence, it is only fair to believe

that the lining epithelium of the ciliary body in the zonule region undergoes a differential development and forms the dense fibres of the zonule. This view is further strengthened by the anatomy of the zonule proper. As we know, two neighboring bundles of fibres encircle one ciliary process and then diverge in a brush formation to encompass the lens. Part of the fibres merge into the anterior capsule, a few are attached to the equatorial region, while the rest fuse with the posterior capsule. This attachment would tend to show that the origin of the zonule is in the immediate region of the ciliary processes.

DEVELOPMENT OF THE VITREOUS.

Only recently have various authors accepted any one theory regarding the origin of the vitreous. Schöler's original view that the vitreous was a connective tissue structure was accepted until Tornatola and v. Lenhossek advanced the ectodermal origin of the vitreous. The former believed that the retina alone was concerned in its development, while the latter author advocated the theory of the lenticular origin. To Van Peè we owe the now universally accepted view that both mesoderm and ectoderm, lenticular and retinal, are concerned. From the rounded nodules described during the development of the lens arise the fibres that radiate from the posterior surface. These grow rapidly and soon show a dichotomous branching. As a result, there soon appears a fibrillar network, arising from the posterior surface of the lens and spreading backward into the vitreous chamber. In the lenticular base of this network are some nuclear elements which disappear soon after the lens vesicle separates from the surface ectoderm. These are the ectodermal vitreous cells of Seefelder. Compare Fig. XLI.) Upon the disappearance of these cells and coincident with the formation of the posterior capsule, the fibres become independent of the lens. They undergo a distinct radial and meridional arrangement. Similar fibres arise from the lining retinal ectoderm of the optic cup and have their origin in the same rounded cellular nodules. These fibres undergo a growth similar to the lenticular fibres and partially fill the vitreous cavity. As the differential development of the retina progresses, the fibres become separated from the retina, first near the entrance of the optic nerve and then gradually advancing forward. The retina lying between the ora serrata and the zonule of Zinn continues to produce fibres long after the remaining portions of the retina have ceased. The union of the retinal and lenticular fibres does not fill the vitreous chamber

completely, however. As the hyaloid artery advances into the eye, it is accompanied by mesoderm. This tissue unites with the mesoderm that enters the mouth of the cup around the edge of the lens and forms a coarse network upon which the fibrillar structure of the vitreous advances. Ultimately these mesodermal elements atrophy and disappear. However, the *vitreous funnel,* that space from the optic nerve head to the lens, is filled with a mesodermal network, much coarser and denser than the surrounding. In the interstices of this appear the first evidences of vitreous fluid. Thus it can be seen that both ectodermal and mesodermal elements enter into the construction of the vitreous, though both ultimately disappear to a greater or lesser extent.

DEVELOPMENT OF THE IRIS AND CILIARY BODY.

The development of the iris and ciliary body begins relatively late in embryonic life. The ectodermal lips of the optic cup remain quies-

Fig. 33.—Fetal Eye at the Beginning of the Third Mouth. (Bach and Seefelder.)

cent during the development of the lens, tunica lentis vasculosa, and cornea, and the only manifest signs of growth consist in a slight increase in the size of the individual epithelial cells. At about the begin-

ning of the third month the embryonic situation is as follows: the double-celled anterior ectodermal lips of the optic cup, as yet undifferentiated, are covered by a prolongation of the mesoderm forming the pupillary membrane. The region of the ciliary body shows no ectodermal differentiation, although the mesoderm between this area and the sclera is markedly thickened by a conglomerate mass of cells. (Fig. XXXIII.)

The epithelial differentiation begins during the first part of the third month and involves the ciliary body more than the iris. It consists in a rapid, uniform retraction of the retinal epithelial layer away

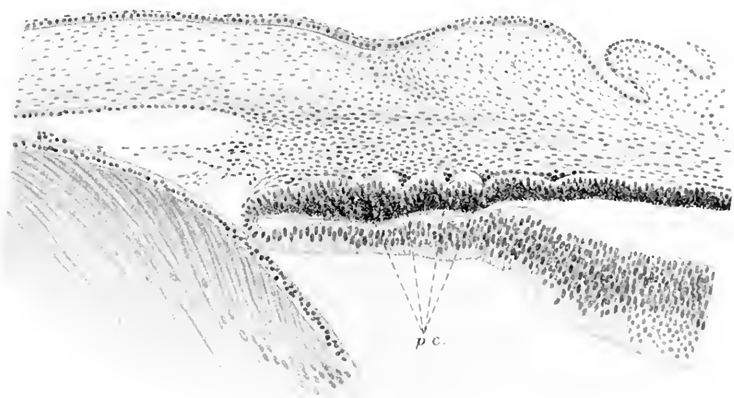


Fig. 34.—First Appearance of Ciliary Processes in an Eighty Millimeter Fetus. (Bach and Seefelder.)
pc, Ciliary processes.

from the edge of the optic cup to about the region of the ora serrata. This is replaced by high cylindrical epithelium growing in from the edge of the cup. The line of demarcation between the retracted and the new epithelium is not sharp, but remains hazy for a considerable period of time. At the same time, the pigment epithelium becomes higher and more cylindrical, so that its nuclei are forced to lie in two or more uneven rows. (Fig. XXXIV.) During this period there can be noticed a small annular space at the very margin of the lips of the cup between the outer and inner epithelial layers. This is the *ring, marginal or circular sinus.* (Fig. XXXV.) It is filled with a peculiar sort of cell, somewhat resembling epithelium, but differing markedly in the main. This sinus enlarges considerably during the next three months, but becomes obliterated during the seventh month of intra-uterine life.

During the second half of the third month, the folds from which the ciliary body develops begin to make their appearance. They are

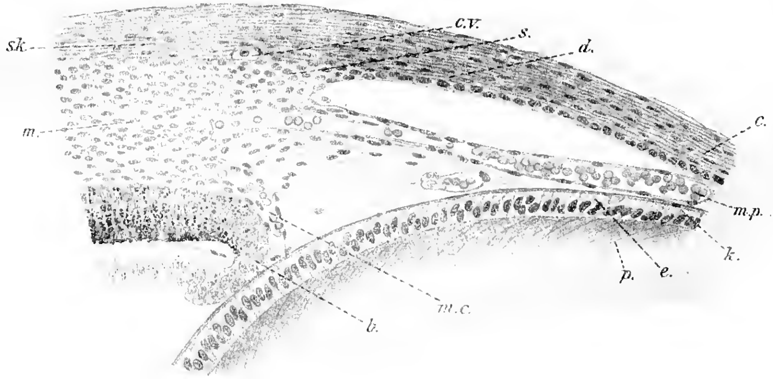


Fig. 35.—Eighty-eight Millimeter Fetus. First anlage of ring sinus. (Bach and Seefelder.)

c., Cornea; *s.k.*, sclera; *c.v.*, canal of Schlemm; *m.*, anlage of ciliary muscle; *m.p.*, pupillary membrane; *k.*, lens capsule; *e.*, lens epithelium; *b.*, edge of optic cup.

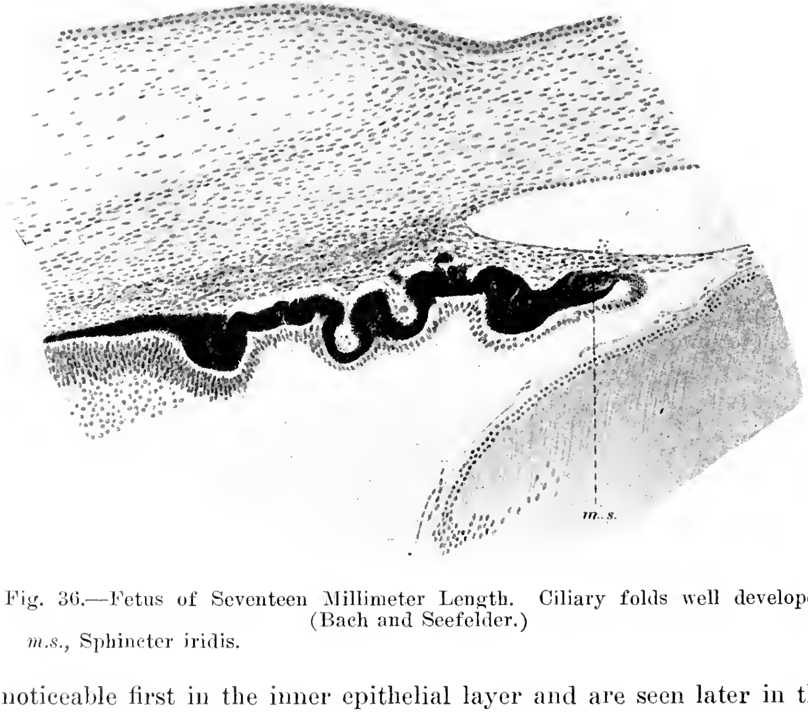


Fig. 36.—Fetus of Seventeen Millimeter Length. Ciliary folds well developed. (Bach and Seefelder.)

m.s., Sphincter iridis.

noticeable first in the inner epithelial layer and are seen later in the pigment layer. Into the depths of these folds dips the overlying mes-

oderm, accompanied by many small vessels. The origin of these vessels will be dealt with in a special section devoted to the vascular development of the eye. This ingrowing mesoderm arises from the thickened layer that preceded the formation of the epithelial folds.

Gradually the iris begins to be differentiated into a separate entity. The two epithelial layers show more folds, especially involving the pigment layer. The ring sinus increases slightly in size. (Fig. XXXVI.) This all occurs during the fourth month and marks the period of the first appearance of the *sphincter muscle* of the iris. This varies in various embryos. The smallest specimen in which the sphincter

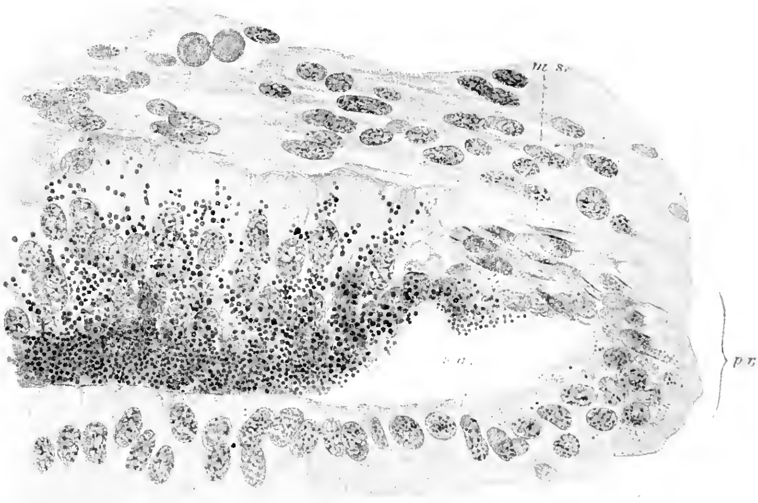


Fig. 37.—153 Millimeter Fetus, Showing the First Signs of the Sphincter of the Iris. (Bach and Seefelder.)
ms, Sphincter iridis; *pr*, pupillary edge.

anlage could first be seen measured 15.3 cm. (Seefelder.) In this one, at various points of the periphery of the lips of the optic cup, or as it should now be called, the pupillary edge of the iris, the epithelial cells contain short nucleated muscle fibrils. They lie within the cell and very close to the pupillary edge. As yet there is no meridional arrangement of the fibres. (Fig. XXXVII.) This specimen would tend to settle any doubt as to the ectodermal origin of this muscle. The ciliary processes become higher and their epithelium thicker during this period. In the ciliary mesoderm can be seen the first anlage of the *ciliary muscle*. Its fibres and their nuclei lie within the protoplasmic outshoots of the mesodermal cells and even in the early

stages show a distinct meridional arrangement. This, as well as the derivation, stands out in sharp contrast to the sphincter iridis. The ciliary muscle is located considerably posterior to the position it occupies in adult life.

During the fifth month the iris and ciliary body undergo radical changes in appearance and size. (Fig. XXXVIII.) The folds of the two epithelial layers of the iris disappear and there is a considerable growth in the vertical plane. The posterior epithelial layer begins to

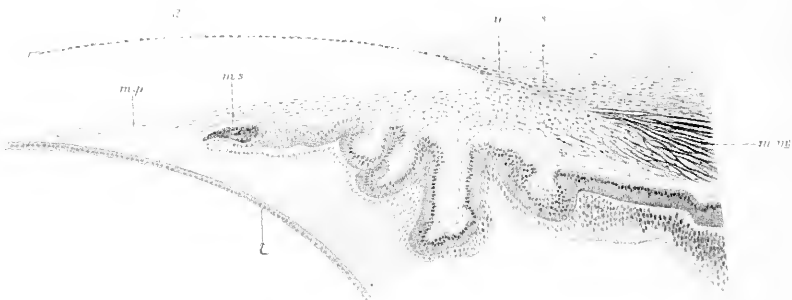


Fig. 38.—Iris and Ciliary Body During Fifth Month. (Bach and Seefelder.) *d.*, Descement's membrane; *m.p.*, pupillary membrane; *m.s.*, sphincter iridis; *u.*, uvea; s., sclera; *m.m.*, meridional portion of ciliary muscle.

be pigmented, so that by the end of this month more than half of its surface is pigmented, though not as heavily as the anterior layer. The ciliary folds increase so radically, both in size and number, that they assume the dignity of processes. Their epithelium becomes larger and more heavily pigmented. The sphincter iridis grows rapidly and soon surrounds the pupil. By this time it has receded somewhat from the pupillary edge and assumed a more meridional arrangement. The ciliary muscle has also made enormous strides and now begins to diverge from its pure meridional arrangement. This is true of the Bruëcke's muscle alone, for the Müller portion has not made its appearance as yet. It is during this period that the *anterior chamber* can be said to develop. It appears first as a mere slit between the cornea and lens and gradually deepens by a retraction of the latter structure, coincident with the growth of the iris.

The sixth month brings but few radical changes in the development. The folds of the iris have entirely disappeared and its growth is one of thickness and extension. The mesoderm begins to retract from the pupillary edge and leaves the first anlage of the *iris crypts.* The first crypt to develop is near the pupillary edge and is one of the largest. The other crypts gradually form by a retraction and disappearance

of small areas of superficial mesoderm. The epithelial layers increase but slowly in size and become more densely pigmented. Still the posterior layer contains less pigment than the anterior, although the pigmentation has extended to the pupillary edge. The ring sinus, which has attained a considerable size, now begins to disappear. The sphincter iridis grows rapidly and during the course of the sixth month becomes perforated by many of the small iris capillaries and their pigmented outshoots. Accompanying these outshoots are cells of ectodermal origin, called by Elschnig "cell masses" (Klumpenzellen). But the most important step of this period is the development of the divator fibres of the iris. These can be seen only in depigmented sec-

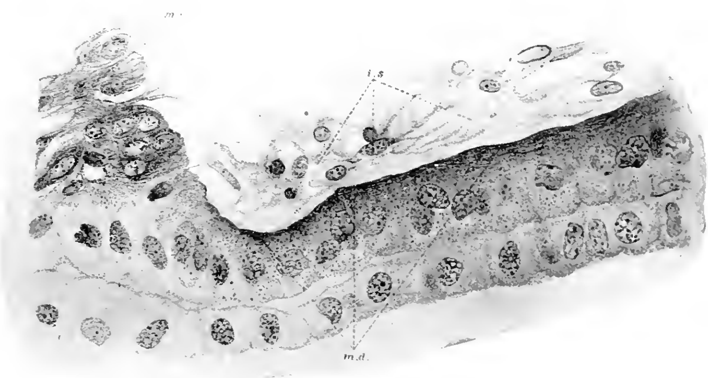


Fig. 39.—Section of the Iris of a Fetus of the Sixth Month, Showing Development of Dilator Fibres. (Bach and Seefelder.)
m.s., Sphincter iridis; *i.s.*, iris stroma; *m.d.*, dilator fibres.

tions and are found within the cells of the epithelial layer. (Fig. XXXIX.) The fibres extend radially, but remain within the cells, and the muscle nuclei are very small, closely resembling the pigment cell nuclei. The ciliary body increases steadily in size, but still remains posterior to the position it attains in adult life. (Fig. XL.) The pigmentation is but slight when compared to that of the iris. The processes are now so large and complex that the examination of a single section would lead to considerable error. The Bruecke portion of the ciliary muscle increases slowly in size and during this month begins to develop circular fibres. Now for the first time can be seen the Mueller portion of the ciliary muscle. This develops anteriorly and very close to the other portion of the muscle. Parts of it, however, impinge upon the root of the iris. In the formation of this

muscle the framework of the ciliary body proper increases greatly in size. The posterior portion of the body, or *orbiculus ciliaris,* now begins to fill the gap between the ciliary body and ora serrata region. This latter is still well anterior to the region it occupies in adult life. The principal changes of the seventh month are those of size and consequent relationship of the iris and ciliary body. The mesodermal portions of the iris undergo a relatively greater increase in size than the ectodermal. The pigment of the posterior layer increases so in density that by the end of this month no difference between the anterior and posterior pigmented layers can be detected. The differential

Fig. 40.—Iris and Ciliary Body of a Thirty-four Millimeter Fetus. (Beginning of seventh month.) (Bach and Seefelder.)
m.m., Meridional portion of the ciliary muscle; *m.a.e.*, equatorial portion of the ciliary muscle; *s.*, sclera; *u.*, uvea; *c.v.*, canal of Schlemm.

growth of the sphincter iridis continues. By far the greatest change is found in the dilator fibres. These can be seen now lying extracellular and in a perfect radial arrangement. Their nuclei are no longer rounded and lie near the basal portions of the epithelial cells. A few new fibres still lie within the pigment epithelium. In the ciliary body retrogressive changes are to be found. The embryonic mesodermal trusswork begins to atrophy, thus giving the ciliary body a rounder configuration. This also reduces the space between the lumen of the anterior chamber and the ciliary body proper. Bruecke's muscle undergoes no change, whereas the Mueller muscle increases considerably in size. We now find a gradual retrogression of the ora serrata, nearing its position in adult life.

The retrogression of the pupillary membrane and its disappearance occurs during the eighth month. As a result the mesodermal portion of the iris undergoes a rapid advancement. It increases in size, then develops, by reason of superficial rarefaction and absorption, the widely

discussed iris crypts. These vary greatly in various specimens, but there seems to be no question but that their beginning development dates from the disappearance of the pupillary membrane. The iris stroma cells now make their appearance as separate entities. It is no longer possible to differentiate between the anterior and posterior pigment epithelium. No change is found in the sphincter during this month, but the dilator fibres increase in size and number. They are entirely free from their mother cells, although occasionally a fibre can be found traversing the belly of an epithelial cell. By the end of this month the muscle has attained the size that it maintains during adult life. Of course, absolute depigmentation is necessary for a study of this muscle. The ciliary processes increase slightly in size, but not in number. Owing to the absolute disappearance of the embryonic trusswork, the ciliary body has assumed nearly the shape that it has during adult life. This form development continues, however, in extra-uterine life. The position of the body, too, has changed and it is fairly well advanced toward the free chamber angle, while the ora serrata continues to recede. The muscular portion of the ciliary body undergoes no change.

The ninth month brings merely the final rounding out in the development of the iris and ciliary body. The pupillary membrane disappears entirely. The rarefaction of the iris mesoderm continues to form the iris crypts of the adult eye. Some of the stroma cells of the iris send out protoplasmic runners and become pigmented. These are the star-shaped cells and chromatophores of the adult iris. The pigment here deposited is all of the fine intra-cellular granular type and begins to make its appearance just before birth. The deposition is then rather rapid, and upon its intensity depends the color of the iris. The unvarying blue of the new-born infant's iris is dependent upon the amount, and light-yellow color, of the pigment within the iris stroma; the change in color is due to a further deposition of pigment and a change in its color. Both layers of pigment epithelium are equal in density and they both extend slightly around the corner of the pupillary edge of the iris. The sphincter now occupies its adult position, somewhat retracted from the pupillary edge. This month brings no change in the dilator fibres. The ciliary body waxes fat, but its adult form and position is not attained until well after birth. The muscles of Bruecke and Mueller increase in size and gradually come closer together, so that their separation becomes difficult. The orbiculus ciliaris shows but few changes since the seventh month. The ora serrata, however, is now entirely behind the ciliary body and lies in the region of the choroid. Thus the iris and ciliary body of

the new-born infant are still in a stage of development, and these portions of the adult eye do not mature until well after the beginning of extra-uterine life.

DEVELOPMENT OF THE RETINA AND OPTIC NERVE.

The primitive retina is seen coincident with the formation of the primary optic vesicle; for the ectodermal cells lining the brain cavity that evaginate to form the ocular anlage, are carried through the various developmental stages until they bloom into the adult retina in all

Fig. 41.—Section Through an Eight Millimeter Embryo (same as Fig. 8) Under Greater Magnification, Showing "Randschleier" of His and Ectodermal Vitreous Cells. (Grosser.)

its complexity. This first stage is seen in an embryo of about $2\frac{1}{2}$ millimetres length. Between the surface ectoderm and the beginning evagination lies a loose area of mesoderm, into which extend protoplasmic prolongations or runners from the basal ends of the retinal cells. Consequently there is no sharp definition at the point of contact. The epithelial cells are one layer deep and so close together that their nuclei form a double row. At the end of the nuclei toward the lumen of the optic vesicle are found the mitotic figures, forming what is known as the Altmann's "Keimzone."

The first important changes from the above picture can be found in an embryo about 4 millimetres long. The vesicle is now more spherical and has grown nearly to the overlying ectoderm, which by this time shows the beginning of the lenticular thickening. But few mesodermal cells can be found between the two layers. The retinal layer is thicker and contains more nuclei than in the previous stage. Between the surrounding mesoderm and the basal (external) cells are more protoplasmic runners, but a sharper differentiation can be detected. These prolongations form a meshwork within which lie but few nuclei, so that a nucleus-free network zone can be said to exist. (Compare Fig. VIII.)

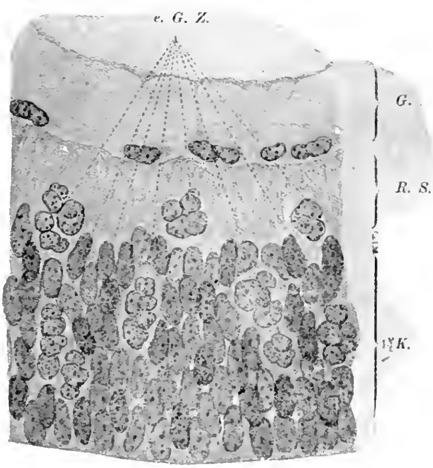


Fig. 42.—*e.G.Z.*, Ectodermal vitreous cells; *G.*, vitreous; *R. S.*, nuclear-free zone of His; *K.*, primary nuclear zone.

The first suspicion of a formed optic cup form is found in a 5 millimetre embryo. In this and in embryos of a few millimetres greater length can be seen a marked increase in the size of the zone of His. (Fig. XLI.) This now extends from horn to horn of the optic cup, but is thickest at the base. It seems to be composed of a nuclear-free syncytium, but contains unique cells in large numbers. They are large, round masses with protoplasmic protrusions and a globular content. Their number increases as the primitive vitreous chamber is approached and they can be seen in various stages therein. There is no doubt but that they play a part in the formation of the vitreous and hence are called by Seefelder *ectodermal vitreous cells.* (Fig. XLII.) The epithelial cells now form a layer five to six cells deep with oval nuclei. No growth of nerve fibres can be observed as yet. The external

epithelial or pigment layer is only two cells deep and already begins to show pigmentation. This first appears at the lips of the optic cup and rapidly progresses toward the posterior pole. The pigment itself is in the form of small, yellowish-brown, round droplets or short rods and is intracellular. The pigment layer is sharply differentiated from the surrounding mesoderm by a distinct basal membrane.

Fig. 43.—Enlarged Section Through a 13.4 Millimeter Embryo. (Grosser.)

The *ganglion cell layer* of the retina develops before the nerve fibre layer and can be first seen in an embryo of from ten to twelve millimetres length. There first appears a new cell layer just external to the "nucleus-free zone" of His, two to three cells deep. The components of this layer are rather large, slender, irregularly-grouped cells, which show a decided tendancy toward layer formation. (Fig. XLIII.) Many mitotic figures can be found. The primary location and seat of greatest growth of this layer forces itself immediately upon our notice: for it occurs in the region that later develops into the macula. This is merely an added proof to the well-known law that *function governs growth*. The development of this ganglion cell layer is so rapid that in embryos of but two or three millimetres greater length, there can be found the first suspicion of a *nerve-fibre layer.*

The individual nerve fibres develop directly from the individual ganglion cells and proceed toward the papilla through the nuclear-free zone of His. This is reduced in size and eventually disappears under the inroads of the nerve fibres. The growth of the nerve fibre and ganglion cell layers keeps apace, though, of course, the internal always lags behind.

The ganglion cell layer grows rapidly, both in length and thickness. In a 31 millimetre embryo, it has advanced well toward the anterior pole and is about twenty cells thick. (Fig. LXIV.) Many new-

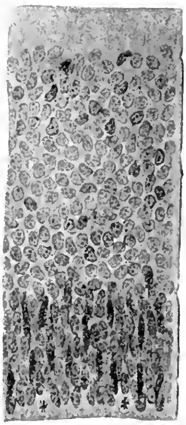


Fig. 44.—Developing Ganglion Cell Layer. (Seefelder.)
N., Nerve fibre layer; *G.*, ganglion cell layer; *K.*, primary nuclear layer.

formed ganglion cells can be found. The nerve fibre layer has proceeded as far anteriorly as its parent layer, but is relatively much thinner.

The next step in the development of these layers can be found in an embryo of about twice the length of the preceding. The nerve fibre layer has increased mightily in size and has attained its mature length anteriorly. The ganglion cell layer, however, is only a little over half as thick as in the preceding stage. This is probably due to the now more or less uniform growth of the entire eye. Fewer new ganglion cells proper are to be found, but on the other hand, nearly every single cell contains a *diplosome*. The cells also send out innumerable *dendrites* in all directions, thus disturbing the uniform layer tendency. (Fig. XLV.) These dendrites also force their way into the depths of the retina and there form a new layer, the *internal plexiform layer,* whose dendritic origin is beyond question.

As the growth of the retina progresses, the ganglion cell layer becomes thinner instead of thicker, as would be expected, except in one area. Here is a rounded prominence of cells protruding into the vitreous noticeably above the plane of the surrounding tissues. This is the site of the *macula* and will be discussed at length later.

Both *internal* and *external molecular layers* develop from the same nuclear zone as the ganglion cell layer, but become separated at a much later date. In an embryo of about 30 millimetres length, the ganglion cell layer can be recognized easily, whereas the molecular layers cannot be differentiated. (Fig. XLIV.) Among the cells of these united

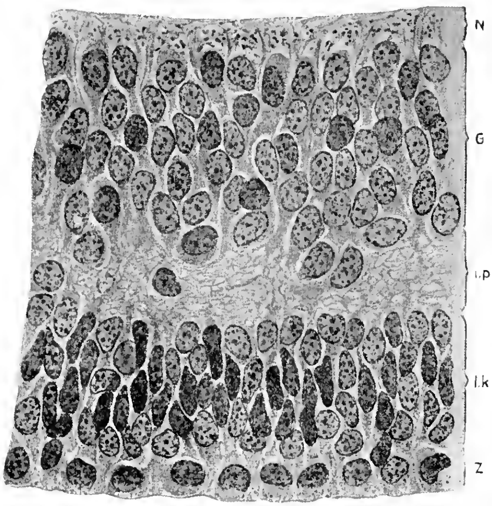


Fig. 45.—Formation of the Internal Plexiform Layer. (Seefelder.) *N.*, Nerve fibre layer; *G.*, ganglion cell layer; *i.p.*, internal plexiform layer; *i.k.*, internal molecular layer; *Z.*, layer of cones.

layers can be seen a few oval, polar-pointed, thin cells with long protoplasmic prolongations that answer to the description of *Müller's supporting cells.* Their antennæ extend throughout the entire thickness of the retina.

Mitotic figures can be found in the molecular layers up to the end of the third month. But at this time a differentiation begins to take place by the layer formation of the external cells. They become darker, smaller, and more or less separated from the internal. This differentiation proceeds very slowly and is not completed before the end of the seventh month. But at this time development of the external molecular layer ceases, as is shown by the similarity of this layer in the

region between the macula and the papilla during the seventh month and at time of birth.

The *inner plexiform layer*, as has been shown, is a differential development product of the main molecular layers: that is, it is formed by the dendritic prolongations of the cells of these layers. The development of the *external plexiform layer* is essentially the same, but occurs at a slightly later date. (Fig. XLVI.)

The development of the retinal area around the *macula* precedes that of the surrounding retina so that the central area is well-formed before the periphery has begun to differentiate. In embryos of the fourth month, this can be clearly seen. But the macula proper is still lacking

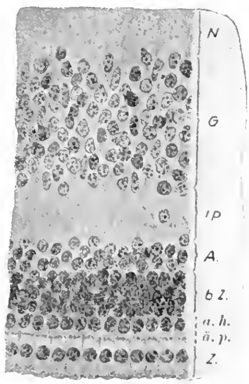


Fig. 46.—Development of the Plexiform Layers. (Seefelder.)
N., Nerve fibre layer; *G.*, ganglion cell layer; *i.p.*, internal plexiform layer; *A.*, inner horizontal layer; *b.Z.*, bipolar cells; *ä.h.*, external horizontal cells; *ä.p.*, external plexiform layer; *Z*, cones.

and hence the retina of this region shows no macular depression. The first suspicion of a fovea appears towards the end of the sixth month and, remarkable to state, is located absolutely as far from the papilla as in the adult eye. The development of this important area of perception is slow, and even at birth, it is still in a rudimentary form, whereas the surrounding and less important area is completely developed. Seefelder makes an important remark in this connection in that he raises the question as to whether or not a large proportion of the so-called monocular amblyopias with normal fundus can be due to a lack of further development of the fovea centralis. Elschnig found the same conditions in the albinotic eyes he so carefully described.

The *cones* of the retina develop before the rods and can first be seen in embryos of from 50 to 70 millimetres length. They are in the form of a one cell layer of epithelial cells, pressing sharply against the mem-

brana limitans externa. Their nuclei are round and upon their external ends have a small depression. The importance of this nuclear invagination has not yet been recognized. Mitotic figures are no longer visible, but the arrangement of the nuclei lead to the conclusion that the stage of mitosis has just been passed. The cones, as do other func-

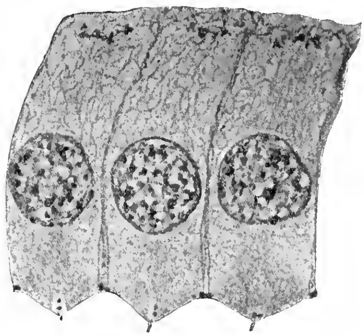


Fig. 47.—Early Cone Cells. (Seefelder.)

tional parts of the retina, differentiate first in the foveal region and then spread toward the periphery of the retina. (Compare Fig. XLV.) By gradual stages this layer develops. The cells first elongate and become cylindrical with nuclei retracted toward the basal or internal side. The nuclei lose their depressions and become

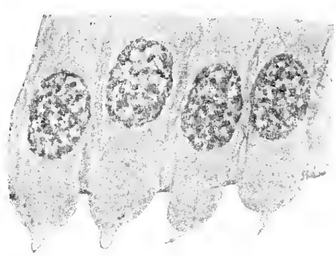


Fig. 48.—Cone Cell of Later Date. (Seefelder.)

rounded and arranged in regular rows. (Fig. XLVII). In the external periphery of the cell a diplosome makes its appearance and from this there develops a protoplasmic thread toward the membrana limitans externa. This thread draws the end of the cell out into a nipple-shaped point that rapidly develops into the cone-shaped end of the adult retinal cone cell. (Figs. XLVIII and XLIX.) Between

the cells can be seen Mueller's radial fibres extending to the limiting membrane. This occurs before the beginning of the sixth month.

As said, the cones develop first in the foveal region and from there spread toward the periphery of the retina. Thus a specimen of the fourth month presents various developmental stages of this type of cell. After the sixth month, the changes in the cone cells consist in the advent of a fibre to each cell and a slight general growth and slight change in shape of the cells.

The *rods* of the retina begin to develop probably toward the end of the fifth month. They lie very close together, in fact so close that it

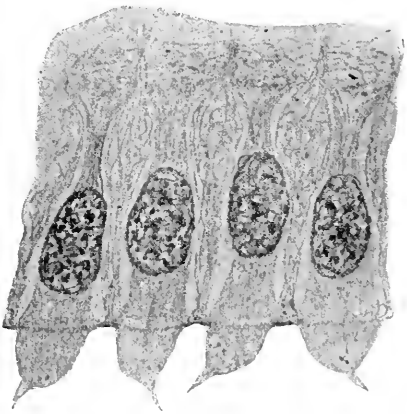


Fig. 49.—Developed Cone Cell. (Seefelder.)

is almost impossible to distinguish one cell from another until well into the seventh month. Even then their diplosomes present a remarkable appearance because of their proximity to each other. Owing to the difficulty of obtaining well-fixed specimens the rods have been but little studied. Certain it is that their development proceeds along lines very similar to those of their neighbors, the cones, only at a later date. Even during the ninth month, the rods in the periphery of the retina are not completely developed.

The *pigmentation* of the outer retinal layer begins early and can be distinctly seen in a 6.5 millimetre embryo. Contrary to other parts of the retina, the first development is in the periphery and from here advances rapidly toward the macular region. In the foveal region, there occurs an increase in the number of cells so that here the layer is from one to two cells deeper than elsewhere. Thus the optic center can be recognized before any differentiation of the other retinal layers has taken place. This increase in thickness gradually advances to-

ward the periphery so that by the eighth month, the pigment layer is uniform in size. The pigment is in the form of intra-cellular, fine, round, brown granules, completely filling the cell except for the nucleus. Under the influence of light, that is, at birth, the pigment cells become more cylindrical and the granules advance slightly toward the inner surface. Mitotic figures are found only in the younger pigment cells, whereas *centrosomes* can be found in each adult pigment cell.

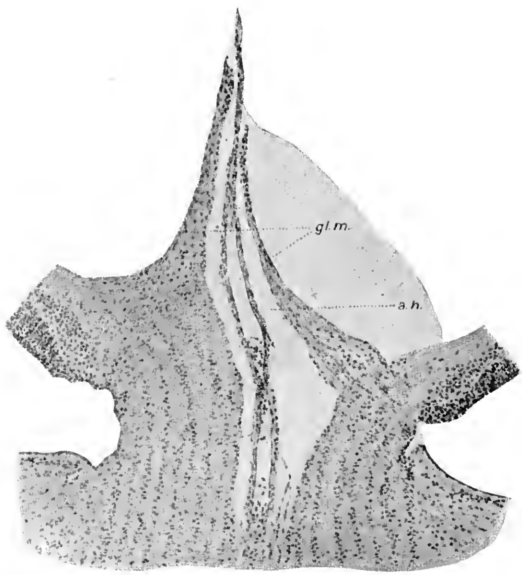


Fig. 50.—Glia Sheath Accompanying the Arteria Hyaloidea Into the Vitreous Chamber in a Fetus 17 Centimeters Long. (Seefelder.)

The *optic nerve* is a developmental product of the optic stalk. The growth of this latter and the appearance therein of the choroidal fissure has already been described and does not need repeating. The transformation of the optic stalk begins in embryos of about 14 millimetres in length where there can be seen an ingrowth of nerve fibres from the retina along the ventral wall of the stalk, displacing the epithelial cells. The growth is very rapid so that the entire optic stalk is completely filled in embryos of about 23 millimetres length. Various intermediary stages can, of course, be seen where a small lumen is still present, etc. The ectodermal cells of the stalk undergo a transformation into glia cells. Within the protoplasm of these cells can be seen the rapidly-growing nerve fibres, proving the assertion that the glia

cells are not merely pushed aside, but actually transfixed. The dorsal wall of the stalk is the last to undergo this change.

During the third month, a more regular placement of glia cells occurs so that they tend to form hollow cylindrical ducts, within the lumen of which can be seen the nerve fibres. This is best seen in a cross-section of the nerve. Surrounding the arteria hyaloidea in its course through the optic nerve is a glia sheath which gradually increases in thickness up to the seventh month. It passes through the lamina cribrosa and spreads over the nerve head in a layer-form. From here, a truncated cone of glia accompanies the arteria hyaloidea into the vitreous chamber, well past the equator. (Fig. L.) From the cells of this cone can be seen fine fibrillæ running into the fibrillar structure of the vitreous and assuming its character. At no place is this glia sheath in apposition with the arteria hyaloidea, but is always separated therefrom by at least a small space. The resorption of this vitreous glia sheath precedes the resorption of the arteria hyaloidea by at least several weeks.

By the time that the nerve fibres have filled the optic nerve proper; that is, in an embryo of about 23 millimetres length, the *chiasm* has begun to develop so that it can be recognized histologically. The nerve fibres do not become medullated, however, until after birth.

DEVELOPMENT OF THE CHOROID, SCLERA, AND ACCESSORY APPARATUS.

The *choroid* is distinctly a mesodermal structure, originating from a vascular plexus. It will be seen that the long ciliary arteries anastomose posterior to the equator of the bulb to form an arterial plexus, completely encircling the eye. This is the anlage of the choroidea. From this arterial plexus there develop the interlacing capillaries that eventually form the chorio-capillaris. The structural framework of the choroid is a differential development of the mesoderm accompanying the bloodvessels, and of the indifferent mesoderm surrounding the globe. The formation of the choroid begins early and is well-advanced by the sixth month.

The development of the *sclera* begins rather early in life. In the undifferentiated mesoderm surrounding the optic cup there can be seen a few fibrous cells of undoubted mesodermal origin lying in between the mesodermal cells proper. These cells proliferate rapidly and soon form a fibrous coat, separating the choroidal plexus from the surrounding mesoderm. This primary sclera increases rapidly in thickness and soon forms a dense fibrous envelope to which the ex-

trinsic ocular muscles become attached. The differentiation of the sclera, being very simple, precedes that of its more complex brother, the cornea.

The manner in which the *extrinsic ocular muscles* in man develop is still an unsolved problem. In birds and in the shark this process has been carefully studied and described, and in all likelihood the human musculature develops similarly. The cephalic myotomes, or muscle plates, exist in the form of what Balfour describes as head cavities. There are four of these imbedded in the indifferent meso-

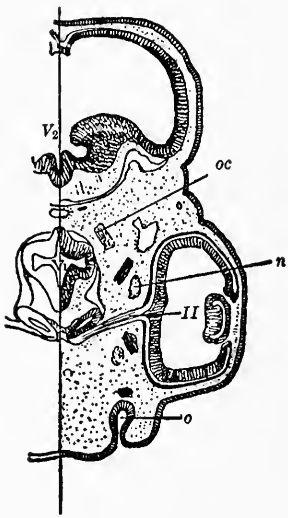


Fig. 51.—Cephalic Myotomes or Head Cavities.

derm of the head and from a portion of their walls develop the extrinsic ocular muscles. (Fig. LI.) Two are premandibular and from these arise the *superior, inferior,* and *internal recti* muscles as well as the *inferior oblique*. From the one mandibular head cavity springs the *superior oblique,* while the retro-mandibular cavity gives rise to the *external rectus.* The muscle cells arise from the walls of these cavities which gradually retrograde and disappear. Into the orbit grow the muscles and, directed by some unknown force, advance to the sclera and become inserted. (Compare Fig. XIV.)

The *orbicularis palpebrarum* is a differential product of the platysma myoides, that premammalian muscle extending over the whole face. The *corrugator supercilii* and probably the *tensor tarsi* have the same origin as is indicated by the common nerve supply, the seventh or facial nerve.

The *lids* first make their appearance in embryos of about 20 mm. or less in length in the form of ectodermal folds above and below the optic cup. (Compare Figs. XI and XIV.) Their development proceeds very rapidly so that the lid edges are fused in embryos only 33 mm. long. This fusion begins at the sides and proceeds toward the middle of the palpebral fissure. This forms a "tobacco-pouch" from which gradually develops the conjunctival sac. Even before this occurs, the tarsal anlage has become noticeable in the form of mesodermal cells in the posterior portion of the lids. The *tarsus* lies dormant for some time, however, until after the tarsal glands are well started. The lid hairs or *cilia* develop as do the hairs elsewhere on the body. The *sudoriparous* and *sebaceous glands* both arise as pouches from the epithelial cells around the anlagen of the cilia. The *glands of the tarsus* originate in the same manner from the epithelial cells at the inner margin of the lids and are distributed equally between the upper and lower lids. Only late in embryonic life is there a majority found in the upper lid. Well into the sixth month, after these glands are formed, the lid edges begin to separate and undergo a form of cornification.

In the embryo about six weeks old there is found a *naso-lachrymal groove*. This lies in a position that in the adult would correspond to a line drawn from the internal canthus to the junction of the lip and cartilaginous ala of the nose. From the deepest epithelial cells of this groove a cord of ectoderm corresponding to the lachrymal passage arises and gradually acquires a lumen. The lower end opens into the nose, while the upper end divides into two passages that eventually open into the *puncta lacrymalis*. At first these lie near the middle of the palpebral fissure, but gradually are drawn toward the internal canthus, pushing before them tarsus and conjunctiva. By the time the puncta have assumed their adult position, they have gathered a mass of tissue before them which gradually develops, or rather retrogrades, to form the *caruncula lachrymalis*. The naso-lachrymal groove eventually disappears.

The first appearances of the *lachrymal glands* are found in embryos of about 24 mm. in length. They are in the form of five or six outgrowths of epithelium, located in the outer part of the upper transitional fold. These growths are at first knob-like, but soon develop into the typical glandular structure. When the embryo is about 60 mm. in length, the gland is divided into an orbital and tarsal portion by the laterally-directed tendon of the levator palpebræ superioris.

DEVELOPMENT OF THE VASCULAR SYSTEM OF THE EYE.

The first anlage of the ocular vessels can be seen in an embryo of about 5 mm. in length. The internal carotid artery has developed well into the head region and has given off its first branch, the *arteria ophthalmica*. This courses toward the eye and some distance behind the bulb divides into two branches. The smaller branch, *arteria ciliaris longa temporalis*, breaks abruptly away from the optic nerve stalk and passes toward the temporal equator of the bulb. The larger branch shortly again divides into two unequal branches, the *arteria*

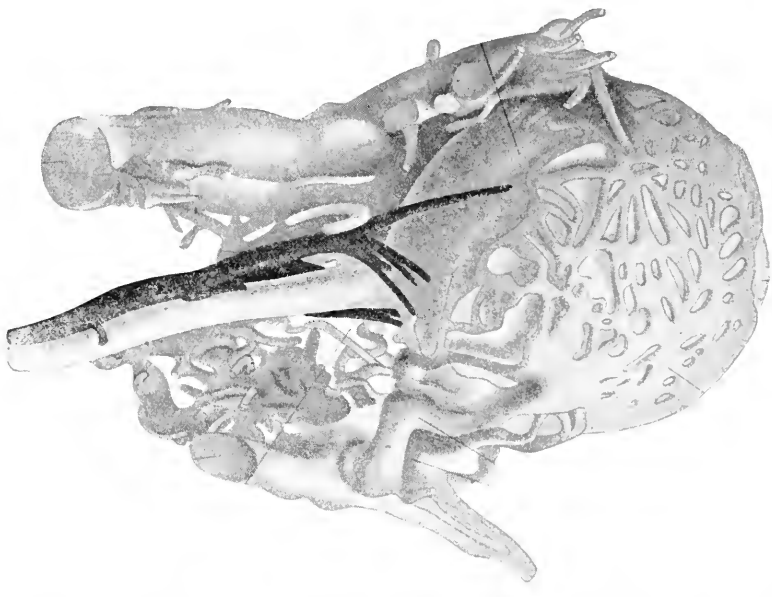


Fig. 52.—Choroidal Plexus Supplied by Ciliary Arteries and Veins. (Dedekind.)

ciliaris longa nasalis, and the *arteria hyaloidea*. The former and the first-mentioned ciliary artery supply a capillary plexus surrounding the bulb and forming the anlage of the choroidea. (Fig. LII.) The arteria hyaloidea enters the optic nerve through the hyaloid fissure, passes through it into the vitreous chamber (compare Fig. XI), and breaks up into an arterial plexus. During its course, it eventually gives off the *arteria centralis retinæ* and the peripheral vitreous arteries. (Fig. LIII.) The ultimate fate of these vessels must be described individually.

The development of the *venous system* of the eye is much simpler than the arterial. There is no hyaloid vein or system. The hyaloid

arterial supply drains from the equator of the lens into the *ciliary veins* which are also the outflow of the iris and ciliary systems. These veins pass directly through the choroidea into the *venæ vorticosæ* which in turn unite to form the *ophthalmic vein.* This blood eventually reaches the *internal jugular vein* after passing through the intermediary *vena anterior centralis* and *vena capitis lateralis.*

The immediate blood supply to the embryonic eye had best be described under three separate captions: the *hyaloid system*, the *ciliary system*, and the *retinal system.* The venous return flow will be mentioned briefly with its corresponding arterial supply.

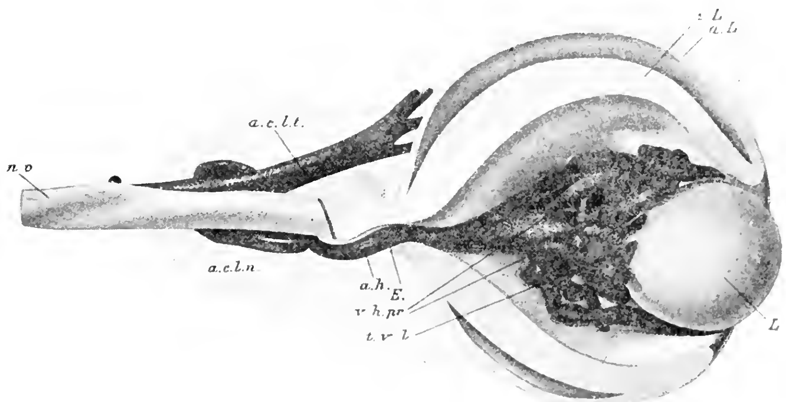


Fig. 53.—Arteria Hyaloidia Propria. (Dedekind.)

The arteria hyaloidea is the first vessel to bring any nutrition to the developing eye. It first makes its appearance in embryos of about 8 mm. in length and is in the form of an arterial bud, imbedded in mesoderm, headed toward the optic stalk. During the third week it enters the choroidal fissure accompanied by some of the surrounding mesoderm. Its growth through the anlage of the optic nerve is rapid and it soon emerges into the cavity of the optic cup. In a direct line anteriorly it grows through the vitreous chamber until about one-half of the length has been traversed. Then the first true division of the arteria hyaloidea occurs. (Compare Fig. XLIII.) The main trunk separates into eight or ten branches of equal size which spread peripherally in a meshed formation (anastomosing freely) and enter the tunica lentis vasculosa about half way between the equator and the posterior pole of the lens. (Fig. LIV.) Each branch subdivides rapidly so that the lenticular sheath soon becomes a veritable meshwork

of fine arterioles. These are interspersed by many capillaries, radiating unequally in all directions. These capillaries anastomose freely and pour into the veins whose development and course will be discussed later. Despite former controversies, it is now an accepted fact that here is the first appearance of a vein along the course of the arteria hyaloidea and that this vessel during its entire embryonic life is unaccompanied by any return flow along its course.

At the equator of the lens the arterial branches bend sharply and hook over onto the anterior surface. This bend is comparatively gradual as the lens is still more or less spherical. Just at this point there are vessels in profusion, for here branches from the ciliary arterioles

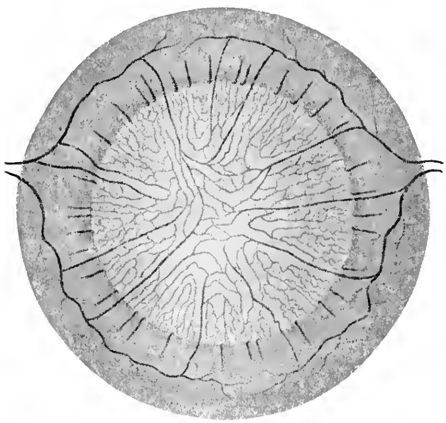


Fig. 54.—Arteria Hyaloidea and Tunica Lentis Vasculosa. (Schultze.)

penetrate the retinal epithelium to anastomose in a most heterogeneous fashion with the vessels of the tunica lentis vasculosa. The veins of this tunic also gather here to form the main venous trunks that ultimately pour into the venæ vorticosæ. The course of the vessels as they pass through the vascular sheath over the anterior surface of the lens is not radial, but assumes the form of a finely-woven meshwork. They anastomose freely with one another and a third blood stream is added to the already existent supply. The most anterior branches of the long ciliary arteries course through the mesoderm that covers the surface of the iris and continue on to join the vessels of the lens tunic. They bend over the pupillary edge of the iris and lose their identity in the subsequent anastomoses. But two areas of the entire lens surface remain comparatively free from vascularization and these are the anatomically anterior and posterior poles of the lens.

The venous outflow from the hyaloid system is rather unique. Prac-

tically the entire posterior surface of the lens is supplied with blood that flows toward the equator through the many vessels of the posterior vascular meshwork. The veins to be seen along the hyaloid system are found slightly posterior to the equator of the lens and are directed toward the equator. In other words, the venous and arterial flows here are in the same direction. The large venous trunks, thus formed, pass directly into the ciliary region and ultimately into the venæ vorticosæ.

As the first subdivisions of the arteria hyaloidea approach the periphery of the lens, they again divide rapidly and some branches develop backward into the vitreous chamber. These remain in the periphery of the vitreous, but do not extend completely backward into the posterior regions. They anastomose freely, but remain very slender and unaccompanied by veins. At no time do they send branches to the retina. The extreme posterior regions of the vitreous are supplied by a few branches of the retinal arteries that develop anteriorly. These minor vitreous vessels are among the first to disappear when the retrogression of the hyaloid system begins.

The hyaloid system and the tunica lentis vasculosa reach the height of their development during the sixth month. By this time the branches of the arteria hyaloidea propria that are given off at the entrance of the nerve head into the eyeball are well developed and are known as the *retinal arteries.* Paradoxical as it may seem, the hyaloid system is not completely developed until its retrogression has begun to occur. This starts during the third month of embryonic life and continues slowly until the seventh month. The first retrogressive steps seen consist in a gradual disappearance of the small branches of the arteria hyaloidea propria, advancing toward the periphery. During the sixth month and first part of the seventh, the disappearance of the hyaloid system in its entirety occurs by a rapid absorption of the vessels. Accompanying this is an equally rapid disappearance of the tunica lentis vasculosa. Occasionally the arteria hyaloidea propria fails to absorb completely and we then find the anomaly known as the "persistant stump of the hyaloid artery." Again it may be the vascular sheath of the lens that remains present in toto or in part and we then have the clinical condition described as persistant pupillary membrane.

The ciliary system is simpler than the hyaloid and develops in such a form that but few retrogressive changes occur before birth. As was briefly mentioned, the arteria ciliaris longa temporalis is the first offshoot of the ophthalmic artery, breaking away abruptly and coursing toward the temporal side of the bulb. It thereafter passes through the mesoderm, now differentiating to form the sclera and choroid and

gives off innumerable small branches. The first of these eventually form the *arteria ciliaris post. longis.* Shortly before reaching the equator, the main ciliary artery divides and partially loses its identity in forming the plexus that later develops into the vascular portion of the choroid. A few single trunks, however, continue their course on toward the anterior aspects of the eye. In the ciliary region many fine branches are given off which rapidly break up into the capillaries that dip into the mesoderm of the ciliary processes. After passing this region, the main arterial branch furnishes the blood supply to the iris

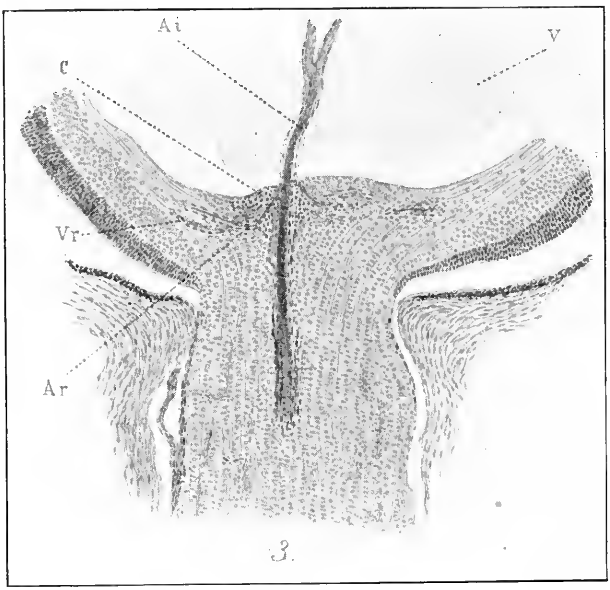


Fig. 55.—Arteria Hyaloidea Entering Vitreous Chamber. (Versari.)

and forms the *circulus iridis, major* and *minor.* By this time, the vessel has become a mere thread and as such it passes through the pupillary area, entering the tunica lentis vasculosa as the *ring artery.* Here a free anastomosis with the hyaloid system occurs and ends its existence.

The course of the *arteria ciliaris longa nasalis* is essentially the same as that of its temporal brother. It subdivides into the same divisions and supplies corresponding areas on the nasal side of the bulb. The first anastomosis of the two long ciliary arteries occurs in the formation of the choroidal plexus, posterior to the equator of the eye. The second is through the capillaries of the ciliary region; the third, through the arterial circuits of the iris; and the fourth and last anastomosis

occurs when they lose their identity, become ring arteries, and enter into the formation of the tunica lentis vasculosa.

When the hyaloid artery enters the choroidal fissure, it is accompanied by the mesoderm which surrounds it on all sides. This tissue accompanies the vessel up to the vitreous chamber, stopping there abruptly and forming a small button over the head of the embryonic optic nerve. (Fig. LV.) It does not primarily overlap on to the retina. From this tissue, there develops a mesodermic network underneath the nerve fibre layer, spreading equally in all directions. This is the so-called membrana retinæ vasculosa, formerly supposed to be a separate membrane, but now universally recognized as an integral

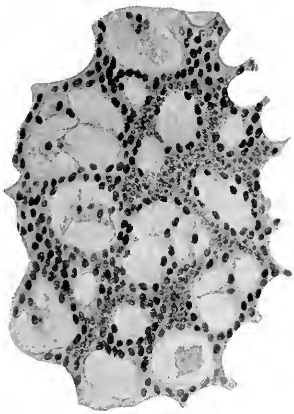


Fig. 56.—Membrana Retinæ Vasculosa. (Schultze.)

part of the vascular system of the retina. It develops equally in all directions until the ora serrata is reached (during the sixth month). Naturally, the inferior nasal portions of this tissue first reach their goal and cease further development.

Upon this network, which lies underneath the nerve fibre layer develops the vascular system of the retina. The arteries begin as outshoots of the arteria hyaloidea and first make their appearance in a fetus of about ten cm. in length. They then develop very rapidly, remaining within the plane of the membrana retinæ vasculosa. (Fig. LVI.) Gradually arterioles spring out and burrow into the depths of the retina, so that by the end of the sixth month, the entire retina is fairly well vascularized. The membrana retinæ vasculosa gradually loses its character and merges with the internal layers of the retina.

A few veins appear within the optic nerve at a rather late period. Toward these trunks, from which develop the central retinal veins, ad-

vance the smaller veins that develop within the retina proper, and by the time an arterial supply is well established, a venous return flow can be said to exist.

I wish to express my thanks to Professors Grosser and Tandler, and especially to Dr. Seefelder, for their kindness in allowing me to reproduce illustrations of the various embryos in their possession.—(H. S. G.)

See, also Vol. IV, pages 2584-2592 of this *Encyclopedia,* wherein the comparative embryology of the ocular apparatus of Birds is described and illustrated.

Deviating eye. Strabismic eye. Deviation of the eye. Squinting eye. This is partially considered under **Angle of deviation,** Vol. I, p. 474 of this *Encyclopedia.* As is well known, in heterotropia, while one eye fixes the object gazed upon the visual axis of the other deviates from the fixation point. Under certain test conditions the same is true of heterophoria—or *latent* deviation. Tests for the various forms of deviation (practically for the different classes of heterophoria and heterotropia) will be found under appropriate headings, but especially under **Muscles, Ocular.** Of these, one of the best is Duane's test. A candle having been placed in front of the person to be examined, a screen is held before one eye for a time and then suddenly transferred to the other side. The existence of deviation in the first eye is recognized by a sudden apparent displacement of the candle-flame in the direction opposite to that in which the eye has deviated.

Deviation, Conjugate. The forced and persistent turning of eyes and head toward one side, observed with some lesions of the cerebrum. It is a rare symptom and was first shown by Prévost to attend an apoplectic attack. It is also seen in tumor of the brain and other cerebral diseases. This combined motion of the eyes and head is caused by a nervous influence arising in the opposite hemisphere; in other words, the eyes look *at* the lesion and *away from* the paralyzed side of the body. Conjugate deviation of the eyes is a temporary phenomenon passing over within a few hours after the attack—usually apoplectic—that gave rise to it.

Deviation of light. In *optics,* the change of direction which a ray of light undergoes in passing from one medium to another. By *chromatic deviation* is meant the angle between any colored ray—or ray corresponding to a fixed line of the spectrum—and the original white ray decomposed by refraction at any surface into a bundle of colored rays. It is called the deviation of that color or fixed line. The difference of the deviations of two colors, or fixed lines, is the *dispersion* of those colors or fixed lines. *Minimum deviation,* or least

change of direction, for a ray passing through a prism, takes place when the angles of incidence and emergence are equal. See **Ophthalmic lenses and prisms.**

DeVilbiss eye irrigator. An effective, though patented, device for washing out the conjunctival sac, cleansing corneal ulcers, etc. It throws a fine and non-irritating stream or spray of any solution.

The De Vilbiss Eye Irrigator.

Devil's hand. LYCOPODIUM SELAGO. According to Pliny, the smoke of devil's hand was an excellent remedy for various affections of the eye.—(T. H. S.)

Deviometer. An instrument for measuring the degree of squint. Nelson Black, Worth, Priestley Smith, Duane and others have described the instrument. See **Angle of deviation,** page 474, Vol. I of this *Encyclopedia.*

de Wecker. See (*de*) **Wecker.**

Dexiotropic. DEXTROTROPOUS. Turning towards the right.

Dexter-diagonal. A diagonal from the upper left hand to the lower right-hand angle.

Dextrad. Towards the right side.

Dextro-compound. Any substance which rotates dextrally the plane of polarization of light.

Dextrogyrate. Turning the plane of polarization to the right.

Dextrogyrous. Circling to the right.

Dextrophoria. This term has been applied by Valk (*Ophthalmic Record,* Dec., 1912), who believed that we may have an anatomic condition of the lateral moving muscles that tends to turn each eye to the right or left. He asserts that this tendency is not uncommon; less frequently *sinistrophoria* may occur.

He ascribes this condition to an increased or decreased development of the internus or externus respectively, and is not able to explain the essential cause, but he believes it to be congenital.

Nearly all cases of squint that are corrected by glasses will be found to have dextrophoria.

For the diagnosis of this condition the routine methods of examination will not suffice; but the tropometer of Stevens, rightly used, is the only method by which the diagnosis can be made. To these conditions Valk lays some of the occasional failures in the operative correction of strabismus.

In two thousand cases of refraction from Valk's private records of the last six years, dextrophoria and sinistrophoria occurred fifty times in connection with heterophoria, and also in many cases of heterotropia.

In ordering prisms, Valk occasionally orders one base in over one eye, base out over the other, with good results.

He refers to the value in these cases of the tucking operation, first described by him in 1895.

Dextrorotation. Rotation to the right.

Dextrosazon. A sugar derivative found in the vitreous. See p. 2262, Vol. III of this *Encyclopedia*.

Dextrotorsion. Positive declination. When oculo-muscular conditions are such that the vertical meridian of the eye is tilted towards the right it is called dextrotorsion, and constitutes a form of cyclophoria (q. v.).

Diabetes insipidus, Ocular relations of. Polydipsic amaurosis. Polyuric amblyopia. Visual disturbances associated with this symptom-complex are rare. When present, whether as cataract (Schmidt-Rimpler), neuritis optica, hemianopsia (mostly bitemporal), optic-atrophy, paralysis of the eye-muscles, retinal hemorrhages, etc., they can generally be traced to the primary ailment, usually certain brain lesions, to which the polyuria itself can be referred. Nevertheless some eye diseases of apparently local origin, such as opacity of the lens, have been noted in pure diabetes insipidus.

Lawford (*System of Diseases of the Eye*, Vol. 4, p. 675) remarks that the two chief symptoms of this malady are great increase in the quantity of urine and distressing thirst; hence the terms "polyuria" and "polydipsia"; the latter being given in the belief that the thirst and the consequent consumption of large quantities of fluid were the essential cause of the increased flow of urine. It is now known, however, that there is no constant relation between the amount of urine passed and the amount of fluid imbibed. A patient suffering from diabetes insipidus will pass more urine than a healthy person who drinks an equal quantity of fluid. The secretion of urine in diabetes insipidus may amount to twenty or thirty pints in twenty-four hours, the specific gravity being from 1003 to 1007. The percentage of solids

is low, but the total amount of urea excreted appears to be augmented rather than diminished. There is an absence of albumen and glycose. This disorder has to be distinguished from saccharine diabetes on the one hand, and organic disease of the kidneys, with polyuria as a symptom, on the other. In the former case there is no difficulty; the presence or absence of sugar in the urine at once decides the question. In the latter case, however, the diagnosis, especially in elder people, is not so simple. Renal cirrhosis may be very insidious in onset, albumen in the urine may be small in quantity or not constantly present, and an increased flow of urine may be the most noticeable symptom. In such instances, other aids to diagnosis than the examination of the urine will prevent mistakes. Careful investigation of the vascular system in cases of renal cirrhosis will reveal increased arterial tension, and, in all probability, evidence of degenerate vessels. In diabetes insipidus, the arterial tension is lowered rather than excessive (Fagge). Two cases of diabetes insipidus have been recorded by Galezowski (*Traité des Maladies des Yeux*, 1871, p. 601; and *Traité iconographique d'Ophtalmoscopie*, 2d edit., 1886, Plate V), in which he found retinal hemorrhages. The extravasations were small, situated peripherally, and gave rise to no subjective symptoms. No note is given of the appearance of the retinal vessels, but it is stated that there was no alteration in the papilla, or in any tunic other than the retina. Gayet (*Recueil d'Ophtalmologie*, 1876, Plate V) has recorded a case of paralysis of the right sixth nerve occurring suddenly in a male aged twenty-eight suffering from diabetes insipidus. The urine was limpid, clear, free from albumen, sugar, or phosphates. Improvement of all the symptoms occurred under treatment. This case and Galezowski's two cases seem to merit consideration as true ocular complications of the disease.

Stoewer (*Klin. Mon. für Aug.*, II, Nov., 1912, p. 624) believes that while ocular affections in diabetes insipidus (which is frequently caused by tubercular or luetic diseases of the brain) may be due to the cerebral lesions, there are, however, also cases of genuine diabetes insipidus, without organic lesions, which may perhaps be considered as a vasomotor affection of the kidneys, elicited solely in nervous, hysterical conditions. Stoewer reports such a case, in a miner, aged 23, with the following ocular changes: ciliary injection, abundant deposits on Descemet's membrane, optic neuritis; VR = 6/24; VL = 6/35. Visual field slightly contracted for white; much for colors. The ocular symptoms and the polyuria disappeared under mydriatics and subcutaneous injections of strychnia, so that the writer assumed a connec-

tion between both. Toxic products of a vicious metabolism probably played a part in the etiology.

Diabetes mellitus, Ocular relations of. Diabetic amblyopia. Glycosuric amblyopia. Glucose in the blood and other tissues, an accompaniment of several distinct and different organic lesions and functional disturbances, chiefly of the brain and spinal cord, has long been associated with well-defined ocular signs and symptoms. The direct and indirect effects of this abnormal substance circulating in the blood and permeating the other fluids of the body are responsible for the ocular involvement. Most of these—iritis, retro-bulbar neuritis, oculo-muscular pareses, optic neuritis and atrophy, accommodative failure, refractive changes, retinitis and cataract (see Vol. II, p. 1477 of this *Encyclopedia*)—have been or will be considered under their appropriate headings. In this section one may refer, among others, to the case of a woman, aged 35 years, diabetic, with *punctate retinitis* about the posterior pole of right eye, reported by W. E. Gamble (*Ophthalmic Record,* July, 1906.). The spots were brilliantly white and became widely-scattered. Vessels were normal in size. In the left eye the punctate deposits were most numerous at the nasal side of the disc and at the posterior pole, with widely-scattered spots throughout the retina. Vision was reduced in each eye to 1/vi.

Hayashi (Graefe's *Arch. f. Ophth.,* Vol. 76, p. 159, 1910) studied rabbits which he had made diabetic by injections of amyl nitrite or adrenalin, and dogs whose pancreas had been extirpated. He found the diabetic blood of these animals to have less than normal bactericidal quality, and that the presence of a moderate amount of sugar in the tissues favored the deposit and growth of pus cocci and increased their virulence. Grandclément (Lyon Med., Jan. 16, 1910) writes on the ocular complications of diabetes, and states that thirty patients in whom he saw patches of *retinal hemorrhage* all died within fifteen to eighteen months.

Retinal lipemia has been observed only in severe diabetes and usually near the fatal termination of the case. Valuable cases are reported by Köllner (*Zeit. f. Augenheilk.,* Vol. 27, p. 411, 1911; *Ophthalmoscope,* Vol. 10, p. 535, 1911) and Darling (*Arch. of Ophth.,* Vol. 41, p. 355, 1911), making in all eight cases now on record. Köllner's patient was passing twelve litres of urine daily, containing 2 to 6 per cent. of sugar. The retinal vessels were flesh-colored, and as they approached the periphery became pure white. It was impossible to tell the arteries from the veins. They were all dilated, but presented no other pathological changes, and the retinas were otherwise normal. The blood was found to contain 26.25 per cent. of fatty matter that could be

extracted with ether, and 2.16 per cent. of cholesterin. The choroidal vessels were normal in color. Köllner points out that the oldest patient presenting this condition, so far reported, was twenty-eight years. But Darling saw it in a man of forty-eight, whose urine showed 3 to 6 per cent. of sugar. The ophthalmoscopic picture was practically the same as that reported by Köllner. Staining of blood film with sudan III showed the presence of a large amount of fat in the blood. In the pipette the blood looked like gray milk. Darling explains the normal appearance of the choroidal vessels in these cases as due to the large volume of blood they contain. He points out that the retinal vessels become paler and paler as they become smaller. The lipemia of renal disease, mentioned below, does not often become so extreme as to be noticed with the ophthalmoscope.

In two cases of diabetes mellitus associated with *optic nerve involvement* Hoffmann (*Münch. med. Wochenschr.*, No. 47, 1912) found glycogen in the axis cylinder and sheaths of the nerve, associated with marked changes in the medullary sheaths. In one case lipemia was demonstrable by microchemic tests. Glycogen was also found in the optic nerves of eyes enucleated for various reasons. Further studies are necessary to determine the significance of these changes in relation to diabetes and other constitutional disorders.

Rönne (Graefe's *Arch. f. Ophth.*, Vol. 85, p. 489, 1912) has had the opportunity of making a clinical and pathological study of two recent cases of *diabetic intoxication amblyopia.* The first patient was a man thirty-four years of age. Sugar had been detected in the urine eighteen months before. Vision had been failing for three months and equalled about 3/60 in each eye. In each field there was a large central scotoma, and by the Bjerrum method a paracentral scotoma. Aside from the pallor of the temporal half of the disk the fundus was normal. There was no evidence of an interstitial neuritis of the optic nerves. The second case was that of a man thirty-three years of age. Sugar had been in the urine for three years. Tobacco was used to excess. Sight had been failing for four months and equalled counting of fingers. The only fundus change was pallor of the temporal half of the disk. A central relative scotoma could still be demonstrated. Histologically, in the first case the optic nerves were normal but in the parts of the tracts corresponding to the papillo-macular bundle there were symmetrical foci of advanced degeneration in the anterior part of the chiasm, anterior part of the tract, and in the boundary between the external geniculate bodies and the tract. Each focus was but a few millimeters in extent. While the papillo-macular bundle between these points showed only slight degenerative changes, the foci them-

selves showed marked accumulations of nucleated cells which in places ensheathed the vessels; also a few leukocytes and plasma cells. The medullary sheath was entirely degenerated. In the optic nerve there was also a slight degeneration of the medullary fibers with normal axis cylinders. In the retina there were evidences of degeneration, half of the ganglion cell layer had been destroyed, while the majority of the rest were affected. In the periphery there were no evident changes. In the corpus geniculatum there was a faint chromatolysis of the small ganglion cells earlier described by Rönne as the macular region of the ganglia. The second case showed similar changes. The clinical symptoms admit of the assumption of a segmental degeneration of the nerve fibers.

Reber (*Ophth. Record,* Vol. 19, p. 589, 1910) observed *amblyopia of diabetic origin* in a woman twenty-nine years of age. She was known to have had glycosuria for six months and albuminuria for a time. There were no stigmata of hysteria and no history of the use of tobacco. Except for a slight hyperemia of the nerve head, the fundus was normal. Vision equalled 5/9. There was a scotoma for red reaching out from fixation 7° toward the normal blind spot. The scotoma has persisted with some variation for two years.

C. Stedman Bull (*Trans. Am. Ophthal. Soc.,* 1909) has noted the adverse influence of diabetes in certain operations on the eye. The paper was the outcome of the author's observations on all diabetic patients in his private practice made with a view of determining what class of diabetics, if any, are not fit subjects for operative treatment.

It is well-recognized in general surgery that certain types of diabetics are intolerant of operation. The wounds do not heal, or become gangrenous. Other patients, again, whose general condition cannot be distinguished clinically from the above do unusually well after operation, their wounds healing promptly.

Diabetic patients are generally anemic, the percentage of hemoglobin is reduced, and as a result there is a lowered resistance power.

The diabetic condition is frequently associated with general arterio-sclerosis, and with tuberculosis, and the relationship is more than accidental. The arterio-sclerosis is probably an important, perhaps the most important, factor in the causation of the recurrent intra-ocular hemorrhages which have been so often observed.

Most writers have advised the postponement of all operations except those of urgency, until the urine is free from sugar. But recent investigation has shown that it is not the amount of sugar, or even its presence, which is of the greatest importance, but rather the amount of acetone, diacetic acid and betaoxybutyric acid present, which gives

a more accurate idea of the condition of the patient. Analysis may show little or no sugar in the urine and yet the odor of acetone in the expired breath may be very strong—an evidence of the abnormal product of decomposition of glucose.

It is not wise to make any marked change in the diet of a diabetic patient immediately before operating.

The complications after operations on diabetics which have been most frequent in Bull's experience are iritis, hemorrhage into the anterior chamber, or infection of the wound, manifested by slow healing. In the cases of iritis, there was a marked maceration of the pigment epithelium of the iris, a condition originally noted by Snellen. Bull found a rather marked tendency to infection by micro-organisms after operation, and suggests that it would be well to have tests made of the bactericidal properties of the blood serum in diabetes.

Bull's cases, 115 in number, were: Extraction of cataract, 62; preliminary iridectomy, 40; optical iridectomy, 9; iridectomy in chronic glaucoma, 4.

Of the 62 extractions, 40 were for senile cataract, in patients sixty-five years of age and upwards. All were extractions without iridectomy, and all the patients recovered without serious complications, though the wound healed slowly in 11 cases. In 10 of the 40 cases careful records of the heart, arteries and arterial tension had been kept. These 10 patients had degenerate arteries and high tension and in all of them healing occurred very slowly.

The remaining 22 cases were examples of pure diabetic cataract, in patients between thirty-six and forty years of age. Each case was under treatment and the percentage of sugar was reduced to a minimum, and an endeavor made to eliminate as far as possible acetone, diacetic acid and oxybutyric acid before operation was undertaken. In 6 of the 22 cases profuse hemorrhage into the anterior chamber took place, with several recurrences. In two there were retinal hemorrhages. In 6 an obstinate iritis without much exudation. In the remaining 8 cases no complications occurred.

The cases of preliminary iridectomy, 22 in senile cataract and 18 in true diabetic cataract, gave but little trouble. In 3 cases (senile) annoying hemorrhage into the anterior chamber occurred and the wound healed very slowly. All three patients showed general arteriosclerosis.

The iridectomies for optical purposes were performed on young diabetics, and all did well with one exception, a female, æt. twenty-two, in whom the operation was followed by severe iritis with abundant exudation.

The last group contained 4 cases of chronic glaucoma in diabetics, treated by iridectomy. Operation was undertaken at a time when the urine contained little or no sugar and only a minute percentage of acetone and diacetic acid. All 4 cases did badly and one patient fell into collapse and nearly died. Profuse hemorrhage into the anterior chamber occurred and recurred in all the cases, but there was no retinal hemorrhage. In one instance delirium set in on the third day, but passed off in twenty hours without supervention of coma. This patient died of diabetic coma, eight months later. (J. B. Lawford in the *Ophthalmic Review,* June, 1910, p. 170.)

After a full report of 120 cases of *diabetic cataract* extracted by him Uhthoff (*Practical Medicine Series,* 1910, p. 100; *Deutsch. Med. Wochensch.,* p. 778, 1909) remarks that 5 per cent. of all cataract operations are performed on diabetics and that 0.12 per cent. of all eye diseases are diabetic cataracts. The following complications of the operations were observed: Six per cent. severe iritis; 5 per cent. slight iritis; 1.8 per cent. glaucoma; 1.8 per cent. slight increase of tension. Gangrene of a leg or other complications of diabetes do not, in general, contra-indicate the operation. A special anti-diabetic diet before operation is not to be recommended. V was good (up to 1/iii.) in 68 per cent., moderate (to 1/x.) in 18 per cent., poor (under 1/x.) in 14 per cent. Uhthoff prefers simple extraction and instills eserin. After the operation there is greater danger of infection and hemorrhages than usual. The writer observed 9 per cent. of hemorrhage into the anterior chamber; 4.5 per cent. into the retina. Timely massage is of service in tardy closure of the anterior chamber. For narcosis ether is always to be recommended.

H. Gifford (*Ophthalmic Record,* May, 1911) writes on the necessity for extra care in the prognosis and treatment of juvenile *diabetic cataract.* In this form of the disease the lens opacity often develops rapidly in a week or two. He has found inflammatory complications in these cases very frequent, his own failures amounting to 43 per cent. He urges the importance of examination of the urine in all cases of cataract even when there is a history of traumatism. The essentials of the paper are in the conclusions which are as follows: (1) No diabetic cataract should be operated on without letting the patient or the relatives understand that even if a good result is obtained the patient will probably not live more than a year or so to enjoy it. (2) That the danger of a bad result is much greater than in ordinary cataract, and it involves some danger to the patient's life. (3) That if a good result has been obtained in one eye it is unjustifiable to operate on the other eye.

Cazalas (*Thèse de Toulouse,* 1910; abst. in *Rev. Gén. d'Ophtal.,* 1911, Vol. XXX, p. 358) states that *diabetic iritis* is a rare affection. The cases of iritis from other causes appearing in a diabetic are much more numerous. In either case, the diabetes renders the patient more subject to attacks of glaucoma. Therefore in combating the iritis, the use of atropin must be guarded. The patient should be kept under the most careful observation, and at the first signs of hypertension the atropin must be replaced by eserin.

Wescott and Ellis (*Journ. Am. Med. Assocn.,* Aug. 12, 1911) have written upon *refraction changes in diabetes* and have discussed the reasons for the ametropia.

To the small number (eleven) cases of *transitory hyperopia* in diabetes thus far reported Lundsgaard (*Klin. Monatsbl. f. Augenheilk.,* July, 1910, p. 38) adds two of which the second presents special interest. A woman suffering from diabetes rapidly developed hyperopia fluctuating from 2.50 D. to .5 D. in both eyes. The corneal radii and tension remained constant, and did not vary with the hyperopia. Measurement with and without a cycloplegic gave the same refraction. The left lens while entirely transparent to transmitted light presented on strong magnification a large number of dots, some of which were evidently vacuoles. With the left eye objects were seen irregularly distorted. In this case the decrease in the refraction was evidently not due to changes in the tension or curvature of the cornea, but was in all likelihood dependent on the condition of the lens; neither did the diminution of the hyperopia coincide with diminution or absence of sugar. In Zentmayer's case (*Trans. Sec. on Ophth. Coll. Phys.,* Phila., Dec. 16, 1910) a woman aged fifty-eight with glycosuria, there had been rapid loss of vision for ten days so that she could see better at a distance with her reading glasses than with the naked eye. The vision was 6/60 in both eyes without glasses, and rose to normal with + 2.50 and a weak cylinder. Two months later with + 0.50 and + 0.75 respectively, the vision was 6/4 partly in each eye.

Zentmayer (*Sec. on Ophth., A. M. A.,* 1911, p. 280; *Journ. Am. Med. Assn.,* Aug. 5, 1911, p. 470) reviews several of the hypotheses which have been advanced to explain the decrease which occasionally occurs in the static refraction in diabetes. He reports a case in which the hyperopia of each eye increased about 2 D. with a development of low astigmatism against the rule in a woman aged fifty-eight, in whom the acquired hyperopia was manifestly greater than could be due to simple paresis of the accommodation. The increase of hyperopia coincided with a lessening of the percentage of sugar in the urine. At the end of a year and a quarter the hyperopia had diminished

by about 1.5 D. in each eye. The presence of a transitory astigmatism against the rule is in favor of a lenticular change.

A number of well-known cases of both increase and decrease in the static refraction in the course of diabetes are now on record, whatever the explanation may be.

Gallus (*Arch. f. Augenheilk.*, Vol. 69, p. 59) reports nine new cases of rapid decrease of refraction, making twenty in all now known. The condition occurs acutely, is always bilateral and is transitory, so that the prognosis appears favorable. Weakness of the accommodation is frequent, true paralyses rare. Neither the corneal radius nor the intra-ocular tension is diminished. The lens is clear and unchanged; inverse astigmatism is strikingly frequent. The diabetes was recent in every case; the high percentage of sugar rapidly diminished with simultaneous restoration of the refraction. The cases thus far reported fail to explain the true nature of the disease. Gallus, furthermore, reports four instances of gradual decrease in the refraction in myopes, in whom, in the course of years and long-standing diabetes, the myopia became less. In these latter premature senility is not certainly excluded as the causal factor.

Woelfflin (*Klin. Monatsbl. f. Augenheilk.*, Oct., 1911, p. 426; *Ophthalmology*, Vol. 8, p. 424) observed in a woman suffering from diabetes, aged fifty-six, hyperopia of 2 D. develop in two or three days. There was no change in the corneal radius nor tension. The diabetes was entirely cured, but the hyperopia subsided slowly—relatively late after the disappearance of the sugar. The reporter made the interesting observation that the anterior images of the nucleus of the lens were markedly less luminous than after the disappearance of the hyperopia; this would seem to indicate that the temporary hyperopia was due to increased refraction of the anterior cortex of the lens.

Davis (*Colo. Ophth. Soc.*, Dec. 16, 1911) also observed during the course of diabetes hyperopia of 2 D. with 0.50 D. of astigmatism, which disappeared at the expiration of a month. Kadinsky (*Klin. Monatsbl. f. Augenheilk.*, Apr., 1911, p. 524) reports myopia of 2 D., in a subject aged sixty with 7.4 per cent. of sugar in the urine, changed to emmetropia. Two months later, with a decrease of the sugar to 1 per cent., there was a return to the original refraction. Wescott and Ellis (*Jour. Am. Med. Assn.*, Aug. 12, 1911, p. 556) also record four cases of decrease in the refraction; these cases show that there is no relationship between the change in refraction and the amount of sugar in the urine. They suggest that some other factor than the amount of sugar in the blood may determine such refractive changes.

The *treatment of the ocular complications of diabetes mellitus* is

largely that of the underlying disease. In the conduct of the general disease Croftan believes (Wood's *System of Ophthalmic Therapeutics*, p. 260) that the chief object to be accomplished is to maintain the general nutrition of the patient, to increase the tolerance for carbohydrates and by implication to prevent or reduce the loss of sugar in the urine. It must be understood that in a case of diabetes with the loss of valuable unconsumed sugar in the urine a diet that would adequately feed a normal individual does not furnish the body with sufficient caloric value and as a result the patient, once the deficit is not supplied, consumes his own tissues and emaciates. Here, therefore, whenever possible a metabolic study (Croftan's *Clinical Therapeutics*, 2d Ed., pp. 119-120) should be undertaken to determine this deficit. Such a study is of inestimable value provided the figures obtained are interpreted with due conservatism. If it were true that a diabetic could utilize none of the sugar that enters the blood stream the question of feeding such a case would be theoretically very simple. All one would have to do would be to exclude the carbohydrates from the diet and replace them by fats and albumens of sufficient caloric value to make up the deficit. As a matter of fact, however, only a small minority of the cases of diabetes are altogether unable to utilize any of the sugar; these are the very grave instances that, fortunately, are rare and would be still less frequent if many milder cases were not transformed into severe ones by injudicious feeding. The great majority of the cases can utilize some sugar and it is generally bad practice to withhold this food permanently as a routine measure; for aside from the glycosuria the comfort of the patient, his digestive function and above all the formation of the acetone bodies must be carefully considered in arranging a dietary.

In order to know how much sugar these patients can tolerate the boundary of tolerance must be established; this is a simple matter. The patient is given a diabetic "test meal" containing a series of articles that are free from carbohydrates, and when the urine has become sugar-free, increasing quantities of bread or of some other starchy food. The point at which sugar reappears is determined and this is the boundary of assimilation or of tolerance. The patient not only may, but should, receive a certain amount of carbohydrate corresponding to this amount of bread; a boundary of tolerance determination should then be made at frequent intervals for a time and the dietary changed accordingly.

Three types of diabetes can conveniently be established, viz.: the light, the medium and the severe type. In the first type the urine is easily rendered sugar-free if carbohydrates are withheld for 48 hours;

these cases can even tolerate the addition of considerable quantities of white bread or of its equivalent to the diet without passing sugar. In the medium cases it takes fully two weeks to render the urine sugar free on a strict diet, and the boundary of tolerance after this has been accomplished is very low, often zero. The severe type finally cannot be rendered sugar-free even after months of restricted carbohydrate-free diet; here and there the reduction of the albumens, together with the complete withdrawal of carbohydrates, causes the sugar to disappear from the urine, but such feeding, of course, constitutes practical starvation and cannot be borne indefinitely. It is far better in the last deplorable class to allow glycosuria to persist and to devote all efforts towards maintaining weight and general nutrition and towards preventing the dreaded formation of the acetone bodies and the general acid toxemia that their appearance so often ushers in. For an acid toxemia often inaugurates and not infrequently determines the incidence of the most dreaded complication of diabetes, viz., diabetic coma.

It is a fact that is not sufficiently recognized that the complete withdrawal of carbohydrates leads, even in a normal subject, to the formation of these acetone bodies (oxybutyric acid, diacetic acid, acetone) and that giving even a little starchy food to a subject that has been living on a restricted "orthodox" diabetic diet may cause their disappearance. This physiological fact, the explanation of which need not be entered upon in this place, should never be lost sight of; neglect to observe it is often responsible for particularly distressing forms of acidemia with all that that entails. The finer technique of feeding diabetics is exceedingly difficult; the co-operation of the patient is not easily enlisted when it is a question of bringing sacrifices to the demands of a usually voracious appetite; much patience and a great deal of skill on the part of the physician are required and the patient must be kept under careful control for long periods of time. But all these sacrifices are well worth while and lives are often saved by a little firmness, thoroughness and patience. It is altogether deplorable to see the slovenly routine that is so commonly adopted of handing every patient who presents himself with sugar in the urine a diet list on which are printed the articles of food that contain carbohydrate. This method of "treatment" is unfair to the patient and casts reflections upon the honesty of the physician's endeavor to help.

Medicines are of little avail in diabetes. In cases in which leutic origin is suspected iodides and mercury are of course indicated. Arsenic is of no value whatsoever. Opiates can reduce the glycosuria a little in patients living on a completely restricted diet, but they serve

no particularly useful purpose. Salicylates can somewhat increase the boundary of tolerance, but they also irritate the kidneys and are apt to derange the bowel function if given in doses sufficiently large to produce this effect. Alkalies are always useful in diabetes, both as hepatic stimulants and as antacids, i. e., as a prophylactic against dangerous degrees of acidosis; they also aid pancreatic digestion in the bowel, and this is important. Organotherapy promises a great deal for the future but for the present it is impossible to declare anything definite in regard to this matter; that the various pancreas preparations utilized so far are essentially inefficient is established.

Most of the complications of diabetes, and among them the complications about the ocular apparatus yield, as a rule, provided serious destructive changes have not been brought about, to proper correction of the diabetic condition, especially to a proper regulation of the diet. This applies especially to the trophic disorders that are not uncommonly seen and to the skin disorders that may involve the lids. The tendency to furunculosis (yeast given by mouth is often of signal value in diabetic furnuculosis) and purulent infections and the intractable character of the latter must be especially considered; here above all things scientific treatment of the diabetes is an essential prerequisite to proper treatment. Local measures alone rarely lead to the goal.

Diabetic cataract. An opacity of the lens occurring in the course of diabetes and due to defective nutrition. It is, if seen before sixty years of age, generally found to be milky-white in appearance, of soft consistence; and it usually involves the entire lens except the capsule. See Vol. II, page 1477 of this *Encyclopedia:* also under **Cataract, Senile.**

Diabetic coma. This condition, marking the advanced stages of diabetes mellitus, is of interest to ophthalmic surgeons because of the fact that it may set in even shortly after the operation for cataract, and (not uncommonly) end in death.

Hertel (*Woch. f. Ther. u. Hyg. des Auges*, July 31, 1913) found in no other comatose or cachectic condition such a marked hypotonus of the eye as in diabetic coma; a complication, however, not always indicative of an unfavorable prognosis. He ascribes the condition to a probable disturbance of the osmotic ocular processes.

The experimental administration in rabbits, by the mouth and intravenously, of sodium butyrate, sodium isovalerianate, sodium chlorid, sulphate, phosphate, acetate, bicarbonate, sugar and urea resulted in a similar ocular hypotonus. Sometimes normal tension appeared several hours after infusion. In extreme hypotonus the

return to normal was hastened by the injection of normal salt solution. Decreased tension was found to be due to loss of water. Chemical analysis revealed a transference of the injected substances from the blood to the ocular fluid. There was no apparent relationship between hypotonus and blood pressure.

Diabétide. (F.) A general term for all the complications of diabetes.

Diabetischer Staar. (G.) Diabetic cataract.

Diabetometer. A polariscope for ascertaining the proportion of sugar in diabetic urine.

Diacaustic. Formerly, a double-convex lens (burning-glass) employed to cauterize the tissues. In optics, denoting a caustic curve formed by refracted rays: opposed to *catacaustic.*

Diaceratos. A collyrium mentioned by Celsus and explained by him to have received its name because of the fact that horn is one of the ingredients. Its composition is as follows: copper scales and poppy tears, each p. XI; hartshorn, calcined and washed, washed lead, gum, each p. XIV; frankincense p. X xii. In explanation of the preceding signs it may be said that p. = *pondo*, weight; X = the *denarius* sign, the denarius being equivalent to 62 modern grains.

Diacetic acid. This agent is a dense, colorless liquid, of very acid reaction, sometimes found in diabetic and other kinds of urine, where its presence is of grave import. Urine containing it is reddened by the addition of ferric chloride. The acid itself may be artificially obtained by the prolonged treatment of acetic ether with a weak solution of potash, acidulating with sulphuric acid, and agitating the mixture with ether.

Diachylon ointment. Unguentum diachylon, U. S. Hebra's lead ointment. This salve is made from lead plaster, oil of lavender and olive oil.

As an application to the lids in eczema and other forms of ciliary blepharitis, this ancient preparation, diluted with some softer excipient, is often used abroad. Perhaps it is better known there as "Hebra's salve," or "Hebra's diachylon ointment." In the German pharmacopeia equal parts of lead plaster and olive oil are melted together, but a mixture quite as popular is: Emplast. diachyloni, 50.00; vaselini, 15.00. To be mixed in hot water bath.

Diacrocou. Diacrocu. A collyrium mentioned by Celsus and explained by him to have been intended especially for a dimness of the eyes proceeding from the relics of a lippitude. For the exact composition of diacrocou, see **Celsus.**—(T. H. S.)

Diactine. In biology, having two rays.

Diactinic. Transmitting actinic as well as non-actinic rays.

Diaframma. (It.) Diaphragm.

Diaglauciu. (L.) An ancient collyrium attributed to Scribonius Largus, and made, according to Dioscorides, of the juice of *Papaver spinosum.*

Diagnosis, Ophthalmic. See **Examination of the eye.**

Diagnostics in ophthalmology. The qualities requisite in the successful ophthalmologist is a most important subject, nowhere stated better than by Beard (*Diagnosis,* p. 2), who says that the "qualifications requisite in a good diagnostician are not all acquired. Those inestimable, subtler attributes are, in great measure, innate, though they are all susceptible, through proper thought and training, of wonderful development. To meet, professionally the infinite variety of character and disposition of mankind his equipment must be physical and moral as well as mental. He is at once sleuth, advocate and judge. Toward the secretive and suspicious he is like a detective to ferret out the facts and to trace the sequence of things; to the deceitful, the over-voluble and the taciturn he is like a legal inquisitor, to draw forth the whole truth from patient and patient's friends; then, like a justice he sifts, weighs and interprets. Throughout he must be patient, considerate and dignified. Severity of manner, as affected by many of our old-time physicians, is rarely excusable now; while flippancy and levity are faults not to be condoned. Any amount of zeal and interest he may evince is welcomed by his client, provided it is not too plain that he has back of it some selfish motive—that, for instance, his interest is purely from the scientific standpoint. But the slightest signs of indifference on the part of the examiner, such as yawning, asking the same questions over again, or other evidences of abstraction will not be tolerated or overlooked. With the view of inducing candor and insuring freedom from embarrassment the interrogation is best conducted in private or, at least, out of hearing of others. The inquiry is begun, not by asking what the matter is, for that is precisely what the patient, in most instances, would like to find out, but how the consulting party has been troubled, or what he has observed in connection with his ailment. It is especially desirable to know approximately the date of the very beginning of the trouble and the qualities of those earliest signs; and, also, whether or not there had previously been similar attacks. We are all aware how important it is to regard with wholesome skepticism the declarations of patients and their acquaintances. It is a curious fact that even the more intelligent are rarely able to give a clear and concise description of the character and progress of a disorder of the eye; what then can be expected of the more ignorant? Equally unreliable are the statements of their relatives and friends. Bearing this in mind, many

evidently think it smart to break brutally into the patient's narrative from time to time with such expressions as, 'I don't want to hear that,' or 'I don't care what someone else has said.' This is not only belittling to the examiner and uncivil to the patient, but it is impolite and unwise, for it prejudices the attitude of the examined and tends to prevent that reciprocity of interests which is so desirable. Besides, in a mass of this sort of information are apt to lie scattered precious gems of enlightenment. It were better adroitly to steer the recital of the views and conclusions of his doctor, his acquaintances and of himself concerning his malady as nearly as possible in the shortest road of relevancy, but, by all means, to permit the recital. One of the greatest difficulties in conducting an interrogatory is to avoid suggesting too plainly what should or should not be the reply. This applies peculiarly to such matters as the rainbow rings in glaucoma, the wavering vision in intraocular syphilis, etc. It is always advisable, when practicable, to question the near relatives and the consorts of those who consult us. Of still greater value is the evidence given by a physician who may have had the case in charge, and this should be obtained whenever possible."

Diagonal. An oblique line, or one joining opposite angles.

Diagonal eyepiece. An eyepiece upon which, by means of a reflector, the rays of light are made to fall perpendicularly to the axis of the apparatus.

Diagrammatic eye. An ideal eye constructed by Listing (q. v.) for the more exact calculation of the passage of rays of light. It has six cardinal points, corresponding to those of optical lenses and situated on the optic axis.

Diagraph. An optical instrument in which the motions of a tracing point, over a projected image, cause the outline of such image to be recorded. The term has also been applied by Gavart to an apparatus for making drawings of the cranial outlines.

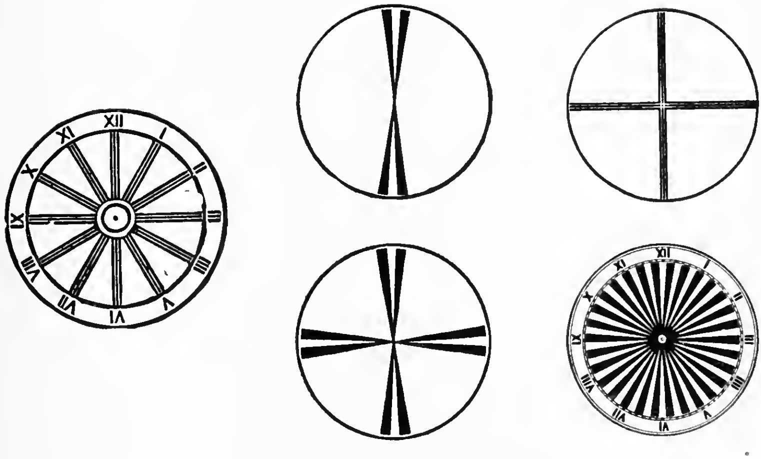
Diaire. (F.) Ephemeral. Lasting only one day.

Dial. In ophthalmology, this word is commonly used to indicate an astigmatic chart. See page 2008, Vol. III of this *Encyclopedia.* The accompanying figures depict Green's dials.

Dialibanou. A collyrium recommended by Celsus as a "particular application" for ocular ulcers. It consisted of copper calcined and washed, poppy tears toasted, of each p. X i; spodium washed, frankincense, antimony calcined and washed, myrrh and gum of each p. X ii. (T. H. S.) See **Diacrocou.**

Dialysis. The mechanical separation of crystalloid from colloid bodies by diffusion. This process is occasionally employed in ophthalmic

investigations. For example, Hegner (*Muench. med. Woch.*, 1913, No. 21) employed Abderhalden's method in examining the serum of a number of patients with uveal disease for the presence of specific uveal ferments. He studied cases of sympathetic ophthalmia, perforating injuries of the globe, non-traumatic inflammations of the uvea, and, for comparison, normal eyes. The results of the examination showed that in certain cases of ocular disease ferments occur in the blood which are specific for uveal tissue. The cases with positive reaction form a characteristic group with typical clinical symptoms.



Green's Astigmatic Dial, with Supplementary Dials.

Protective ferments are particularly liable to occur after a perforating injury leading to a chronic uveitis.

The demonstration of specific ferments was most striking in a case of fresh sympathetic ophthalmia. The reaction was generally negative in perforations not followed by inflammatory reaction (cataract extraction) and in non-traumatic inflammations of the uvea. In a case of punctured wound of the eye with iris prolapse, it was possible during the various stages of inflammation to demonstrate the appearance and disappearance of protective ferments, the formation of ferments being most active during the acute stages, a negative reaction being obtained after subsidence of inflammation.

The presence of these specific ferments in sympathetic disease and in cases liable to sympathetic inflammation suggests a possible causal relationship of these processes to sympathetic disease. (Abstract, *Annals of Ophthalm.*, Oct., 1913.)

Dialytic telescope. A telescope in which achromatism is effected by means of two lenses separated some distance from each other.

Diametral. DIAMETRIC. DIAMETRICAL. Pertaining to a diameter.

Diametric iridectomy. Iridectomy performed on opposite sides of the same eye, so that the pupil extends diametrically from one edge of the cornea to the other.

Diametric pupil. One which has the form of a vertical slit, produced by two iridectomies, one upward and the other downward.

Diamisyos. An ancient collyrium consisting principally of copper sulphate.

Diane. (F.) An ancient name for silver, from the alchemic term Diana, the representative of (luna) the moon.

Dianodal. Passing through a node.

Dianoux's operation for entropion. It consisted in the formation of a marginal and cutaneous palpebral flap, separation of the underlying muscle from the tarsus, and suture of both flaps to the edge of the latter.

Diapedesis. The passage of blood-corpuscles through the walls of the blood-vessels, in contradistinction to the emigration of leucocytes. It is by some regarded as a sort of passive filtration process, mostly due to increased blood-pressure.

Diaphaneity. TRANSPARENCY. PELLUCIDNESS. The capacity of transmitting light readily.

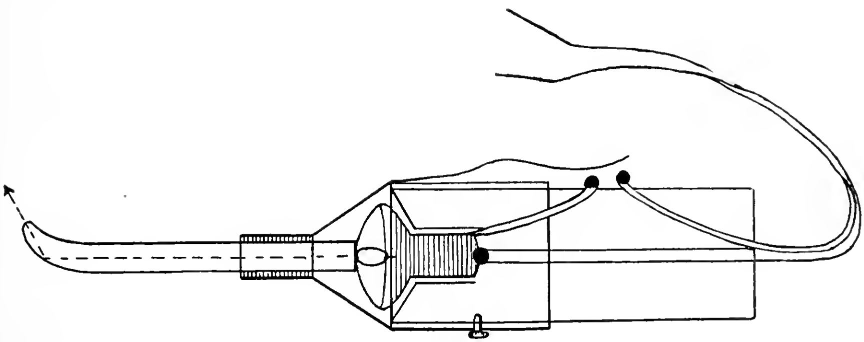
Diaphanometer. An apparatus devised by Donné for estimating the amount of solids in a fluid by observing the degree of its transparency. It consists of a glass vessel having perfectly plane walls, one centimetre in thickness. Water is added to the fluid to be tested until the flame of a candle, held about a metre away from one side of the vessel, can be seen from the other side. This method is applied to the quantitative estimation of albumin in urine. The term is also applied to instruments for measuring the transparency of gases, such as atmospheric air.—(Foster.) See, also, **Tintometer.**

Diaphanoscope. TRANSILLUMINATOR. OPHTHALMO-DIAPHANOSCOPE. An apparatus for illuminating the internal parts of the body—eyeball and orbit, for example—so as to render the overlying structures diaphanous, for purposes of visual examination. In *photography,* it is a camera for the exhibition of transparencies. The various (ophthalmic) instruments and their employment are discussed under the caption **Diaphanoscopy.**

Diaphanoscopy. TRANSILLUMINATION. DISCLERAL ILLUMINATION. By transillumination of the eye is meant the passage of a beam of light,

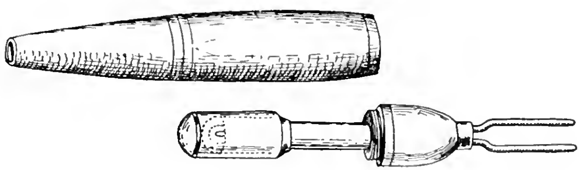
by means of a special lamp, through the eyeball, so that the shadows cast or the changes in the illumination in the pupil can be studied.

In 1884, O. Lange suggested the method in connection with intraocular sarcomata. He allowed the light from a gas flame, focused by means of a convex lens, to fall upon the sclera in a case in which the pupil was widely dilated by atropine. He noted that when the beam fell upon the area over the supposed growth the illumination in the



Lange's Transilluminator.

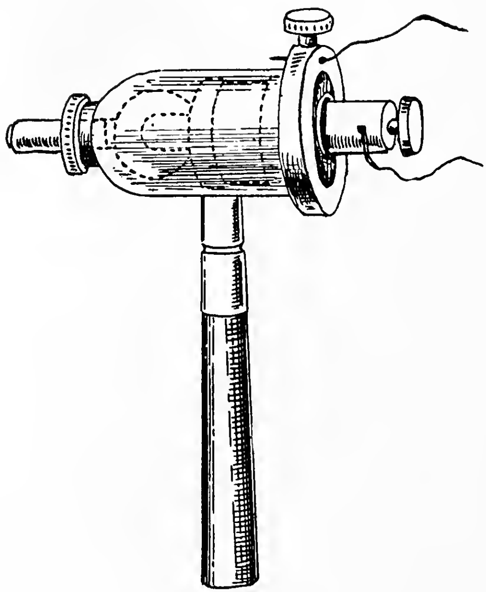
pupil was much fainter than when it fell upon other parts of the sclera. A few years later, Mules, in an article on tumors of the ciliary body, pointed out that a ciliary ectasis produced by a neoplasm might be differentiated from an ordinary one by allowing a beam of light to fall on the sclera and observing the amount of light in the pupil. He considered that the method could be practiced only when



Rochon-Duvigneaud's Transilluminator.

the tissues were considerably thinned. Shortly after this von Reuss devised a lamp which consisted of a small electric light, run by a small battery, enclosed in a metal case and provided with a water jacket to prevent overheating. Leiter modified von Reuss' lamp by doing away with the water jacket and employing a glass rod to conduct the rays of light. Rochon-Duvigneaud, in 1884, devised a lamp which

consisted of a small electric light, run by a current of 10 to 20 volts, enclosed in a horn case, and provided with a glass cone 5 to 6 cm. in length. The light could be transmitted through the sclera by direct application of the glass cone, which did not get hot as in von Reuss' instrument. In 1902, Leber presented his lamp, which is shown in the figure. It consists of a small electric light enclosed in a metallic case. A short rod of glass encased in rubber is in contact with the light and a large amount of the light is conducted along the rod to its end, which, when placed upon the sclera, is capable of illuminating strongly



Leber's Transilluminator.

the interior of the globe. This instrument has found considerable favor, but is somewhat clumsy to use on account of its short, blunt-shape and, further, it gets hot after a few minutes' use. It heats rather slowly, however, and not nearly so rapidly as its detractors would have us believe. In the following year Sachs presented his lamp, which was a great addition to our equipment. It consists of a twenty-five candle power electric light which is covered by a metallic spherical case of about three inches in diameter. It bears a cone-shaped projector of glass which extends from the side of the bulb, at right angles to the handle, as shown in the figure. The glass projector is silvered around its circumference so as to secure as great a conservation of the

light as possible, and is covered by a casing of hard rubber. This instrument gives fine results, but is somewhat heavy and cumbersome to handle in the delicate manipulations that are necessary. The bulb gets very hot after a few minutes' use, but the rubber cone, which is applied to the eye, does not. There has been much error upon this point, several writers speaking of the Sachs lamp as if it were impossible to use it for more than a few minutes on account of the heat. While it is very inconvenient to have the bulb so hot, necessitating

Sachs' Transilluminator.

great care to avoid burning the patient's cheek or brow, the projector does not get appreciably warm after fifteen or twenty minutes' use, and the lamp can be used for a sufficient time to study each case, as the writer has demonstrated repeatedly. The unwieldiness of the lamp is a much more serious and just criticism, and it is difficult to manage it properly in exploring as far back as the equator.

In 1906, Lange presented a new model which is designed to meet one serious limitation in the usefulness of other lamps. It consists of the usual outer case, of hard rubber in this instance, containing a small electric light requiring ten volts. The end of the case is capped

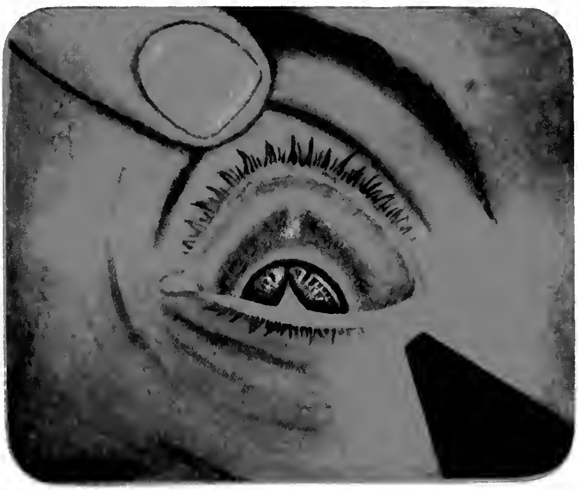
by a nickel clasp which holds a glass rod 5 cm. in length. The end of the rod is slightly curved and ends in a blunt point which permits one to apply it farther back over the equator. It is favorably mentioned by Stephenson, who considers it a "most efficiënt appliance."

At the meeting of the American Medical Association in 1906, Würdemann presented his lamp, which is certainly one of the best. It consists of a tube, about the size of an ordinary fountain-pen containing a small electric light, in the end of which is a covered glass rod, 2.5 cm. by 5.5 mm. The light has an additional thickness of glass on the end, which acts as a small lens and which is in direct contact with the end of the rod, thus conserving nearly all the light. The rod projects a fraction of a millimeter beyond the hard rubber cone, in which the instrument ends, and can be placed directly on the bulbar

Würdemann's Transilluminator.

conjunctiva, even without cocainization. The light is of five candle power, requiring less than 1 volt of current. This lamp does not heat as much as many of the others. Fridenberg has recently modified Würdemann's lamp by constructing the glass rod in the shape of a hook. The curve begins as soon as the rod emerges from the case and is very abrupt. The end of the rod is flat and tipped back so that when the transilluminator is held in the direction of the visual axis the end of the rod can be applied to the sclera as far back as the conjunctival cul-de-sac will allow, thus extending the field of usefulness back into the posterior segment of the globe. This is the object of Lange's construction, but his rod is long and has a blunt end. Fridenberg's is very short—in fact only a few millimeters—has a high curve and flat end, and the light is undoubtedly better conserved. Reuter has also recently devised a lamp. (*Munch. Med. Woch.*, 1913, No. 28.)

Method of transillumination in detail. Absolute darkness is necessary, if the best results are to be obtained. The lids are held back and the point of the glass rod is placed on the skin of the upper or lower lid, or at the external canthus, or elsewhere, depending on the angle required. If a very strong light is required the rod may be placed on the sclera, previously cocainized, but this does not give as much better an effect as might be expected, as the tissues of the lid are easily penetrated. In the use of the Würdemann lamp it is



Transillumination of a Case of Sarcoma of the Choroid. (Thomson.)

possible in many cases to apply the end of the rod to the sclera without the use of cocaine. The observer stands directly in front of the patient, and by varying the angle of the light rays and by causing the patient to look this way and that, can study all the tissues in the anterior part of the globe.

There are two ways of using the method, which should be definitely specified on account of the lack of attention which the more important one has received; first, by observing the variation in the intensity of the light in the pupil when different parts of the sclera are illuminated (the so-called "tumor reaction"); second, by observing the shadows cast on the sclera by normal or abnormal structures within the globe.

The "tumor reaction" was the origin of the method, and has been dwelt on by the earlier writers, most of whom do not mention the "shadow" method at all. The shadow method, which is certainly the more important and widely useful, has been advocated chiefly by the American writers and the later foreign writers. The "tumor reaction" is best observed with the pupil dilated. The lamp is placed over the sclera at the point at which a retinal detachment or other suspicious appearance leads one to suspect a growth, and the intensity of the illumination in the pupil is noted. The lamp is then shifted about at various points and it is noted whether the illumination is brighter outside of the suspicious area. At times when the light is on the edge of a growth, a part of the pupil will remain bright while the rest will be decidedly darker. This is a very striking appearance and gives an indication which can mean but one thing. On the other hand, it is obvious that to judge of the presence of a solid growth by mere difference in the intensity of the light is a method that must be used with great care, and at best is liable to lead to certain errors.

The "shadow" method is applicable to a great variety of conditions other than intra-ocular growths, and besides, is more reliable in the diagnosis of tumors of the anterior part of the globe. It is practiced by placing the rod of the lamp on one side of the globe and observing the shadow cast by the tissues on the opposite side. (See plate.) It is obvious that the majority of cases that will show tumor reaction will also show a shadow of the growth, if it is not too far back, and will show the growth much more definitely and in a way which it is impossible to misunderstand. It must be admitted, however, that if the growth is far back, it is more difficult to use the shadow method on account of the interference of the orbital margins, and the tumor reaction may be more available in such cases. The shadow method is more easily practiced in lightly pigmented eyes, in more prominent eyes, and in the eyes of the aged in whom considerable atrophy of the

uveal pigment has taken place. In children, and especially in those who have brown eyes, the method is difficult and the movements of the eye are very embarrassing. Some cases, on account of heavy pigmentation, show little by transillumination, but it is nevertheless true that the majority of all cases show something by the method. and most cases show a great deal.

There seems to be a general idea that the anterior half of the globe alone is accessible to the transilluminator, but in certain cases it is undoubtedly possible to explore even farther back. According to Stephenson, "with Lange's appliance * * * one may often reach considerably beyond the equator," and this is undoubtedly true of Fridenberg's curved tip.

Lancaster has mounted a small Tungsten lamp at the end of a flexible copper tube, 70 mm. in length and 3 mm. in diameter, attached to a pocket, flash-light battery. By incising the conjunctiva and capsule of Tenon, the lamp can be carried behind the eyeball to transilluminate its posterior segment. This method may be resorted to where the alternative is a more serious operation or fatal delay in reaching a diagnosis. (*Trans. Am. Oph. Soc.*, v. 13, p. 445.)

Cornea. Little additional information is to be gained here besides that which may be obtained by focal illumination. Certain opacities show well and can be localized, but it is important to cut down the current by means of a rheostat so that a feeble light can be secured; otherwise the light will penetrate all tissues alike and no contrasts will be shown. Foreign bodies show distinctly.

Filtration angle. In this situation we have perhaps the most important application of the transilluminator, certainly the most widely useful. The width of the scleral projection and the anterior limit of the ciliary body can be studied in every case, and information of the greatest importance secured. (See plate.) In cases of recent wounds, extending into the ciliary body, the transilluminator usually gives us positive information as to the extent of the injury; and in cases of old injury the interruption in the pigment of the ciliary body often shows very clearly. It is rather surprising that so little stress is laid upon this point, as it is a matter of common experience that the decision in such cases is often difficult and always of importance. The question as to whether or not the ciliary body has been wounded is often a vital one.

Adhesions of the iris at the angle show clearly, as also do small amounts of blood or pus, though it must be remembered that if a large amount of light is used these delicate details do not show so well. For this work a proper rheostat control is absolutely necessary.

Transillumination of the Normal Eye. (Thomson.)

The ciliary body shows as a dark ring, and anteriorly is the scleral lip which projects beyond the plane of the iris.

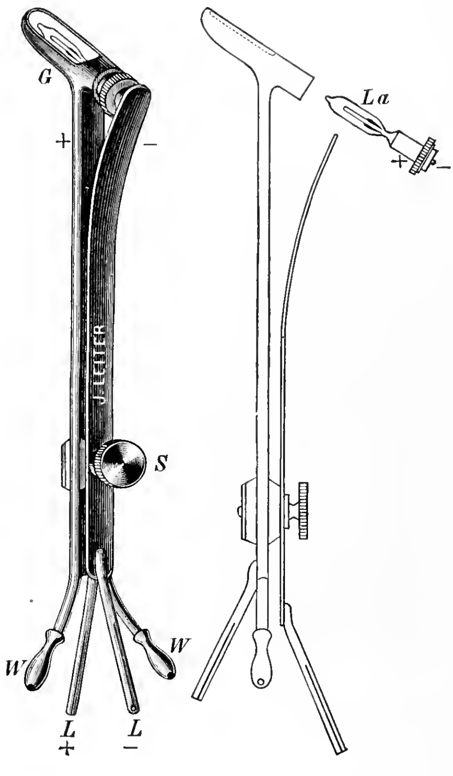
Iris. Details in the iris show with great clearness, and it is surprising to note the atrophic spots in an iris which by oblique light appears normal. Very many normal irides in those of advanced age show thin spots in the pigment, through which the light penetrates with the greatest ease. Old spots of atrophy following "gumma" of the iris, lacerations of the iris after cataract extraction, iridodialysis, and, in fact, any detail in this situation, shows very well on account of the contrasts which the pigmented tissue gives. In certain cases, where the iris is very translucent, more delicacy of detail can be gained by cutting down the intensity of the light, as has been mentioned.

Lens. Details in the lens and anterior part of the vitreous show very distinctly, though the regulation of the light is here of the greatest importance. Lens opacities do not offer much obstruction to the light, and indeed a brilliant pupillary illumination can be obtained through a dense, mature cataract, a fact of great clinical importance in connection with the "tumor reaction." It is possible to make out certain details in the vitreous, retinal detachment, floating opacities, etc., even where a considerable degree of haziness of the lens is present.

Ciliary body and choroid. One of the most striking features of the shadow method is the presence of the dark ring immediately beyond the limbus, which is the shadow of the ciliary body. (See plate.) Its anterior and posterior limits can be distinctly seen, and even the individual processes and the ora serrata can be identified unless the structures are very deeply pigmented. Wounds passing through the ciliary body can be clearly seen, as is shown in the figure. In tumors of the ciliary region, as Stephenson remarks, the method is "quite the most trustworthy means of diagnosis at our disposal." The shadow of the growth may be seen extending from the ciliary body or in the anterior part of the choroid, as the case may be. The color plate (see plate) was taken from sketches of a case which showed a very doubtful looking retinal detachment by the ophthalmoscope. The diagnosis would have been very uncertain and valuable time would have been lost had transillumination not been available. The appearance left no room for doubt, and after enucleation a large melanotic sarcoma was found springing from the choroid.

Marple reports a very curious occurrence in this connection, which is important to bear in mind. The patient presented by ophthalmoscopic examination what appeared to be a neoplasm, but the full illumination of the Sachs lamp gave a negative result. When the rheostat was regulated so as to reduce the brightness of the Leber lamp

by more than 50 per cent., the tumor reaction was obtained. Marple concludes, "that a negative result with a very powerful light does not mean that there is no neoplasm; it signifies that the latter is non-pigmented, or sparingly pigmented. It is probable also that a thin, flat tumor might escape detection, although I know of no case in point." This observation is of great practical importance, not



The Ophthalmo-diaphanoscope of Reuss.

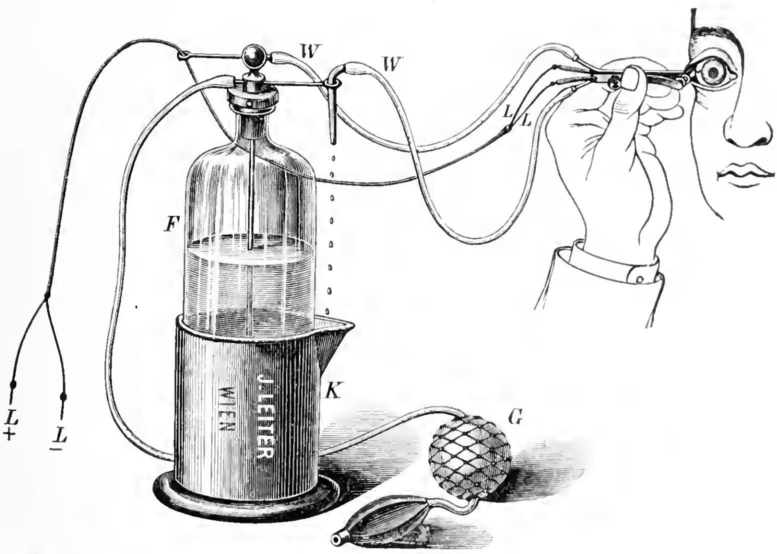
only in tumor diagnosis, but in many other conditions, as has already been mentioned. If the appearance with full illumination is not satisfactory, the light should be cut down by means of the rheostat so as to secure greater contrast, on the same principle that in securing the greatest contrast in photography we use the shortest possible exposure.

Scleral ectasiæ are readily illuminated and, if in the ciliary region, can be studied only with the transilluminator. Foreign bodies, if

Transillumination of an Old Wound of the Ciliary Body. (Thomson.)

near enough to the sclera to cast a shadow, can be clearly seen, even if surrounded by exudates, on account of the contrast between the density of the particle and the exudates. Very dense hemorrhages may interrupt the beam of light so as to interfere with the diagnosis, but recent hemorrhages are fairly translucent and difficulty from this cause is not common.

Finally, it is to be remembered that in the ciliary region the ophthalmoscope is useless on account of the fact that the regions are inaccessible to direct examination, while the transilluminator in the great majority of cases meets just this want. Details can be observed here which cannot be studied in any other way.



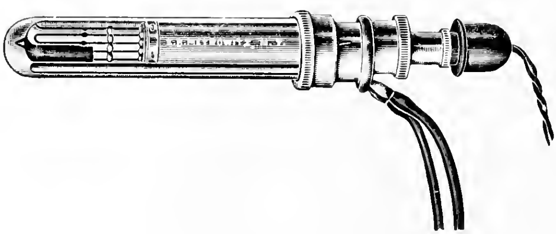
The Ophthalmo-Diaphanoscope of Reuss.

It is not too much to say that the routine employment of the trans-illuminator, in a certain class of cases, should be a part of every thorough examination.—(E. S. T.)

The trade or official name of one of the earliest of these useful devices is the *Ophthalmo-diaphanoskop.* This apparatus is constructed on the principle of Bruck by Leiter (see figures) from directions furnished by von Reuss of Vienna, and is intended to illuminate the ocular interior through the sclera. It consists chiefly of an outer green glass container in which an electric lamp is placed. By a simple device these lamps are readily replaced. The undue heating of the

container is prevented by the circulation about it of cold water, supplied from a bottle by means of an ingenious pumping device. As the cooling of the diaphanoscope may be continued indefinitely the observer proceeds with the examination of the eye without hurry and with greater satisfaction to himself and comfort to his patient than is possible with the Sachs and some other transilluminators. The Reuss apparatus is adapted to independent batteries (four to six small elements), or it may be used with a rheostat and the ordinary wall plate.

The examination of the interior of the eye, the comparison with the other eye to demonstrate the presence or absence of tumors, large intraocular deposits, etc., is carried out as with similar instruments. A more complete description of this instrument may be found in the original article by von Reuss himself in the *Wiener klin. Wochenschr.*, No. 37, 1887.



Ophthalmo-Diaphanoscope. (Hertzell.)

The Hertzell device (see the figures) is fully described (*Berlin. Klin. Wochenschr.*, No. 42, 1909) by the inventor. The temperature (raised by the electric lamp) is kept within bounds by a water-jacket or irrigator.

This apparatus consists of an 80-candle power tubular electric lamp, three-quarters of an inch in diameter, in a metal mounting with connecting plugs, as shown in the cut. Encompassing this lamp is a glass shield, the space between them forming a water-cooling chamber. Another part is fitted inside with a rubber washer to effect a water-tight joint between the parts. It has also the inlet and outlet tubing attachments for the circulating water.

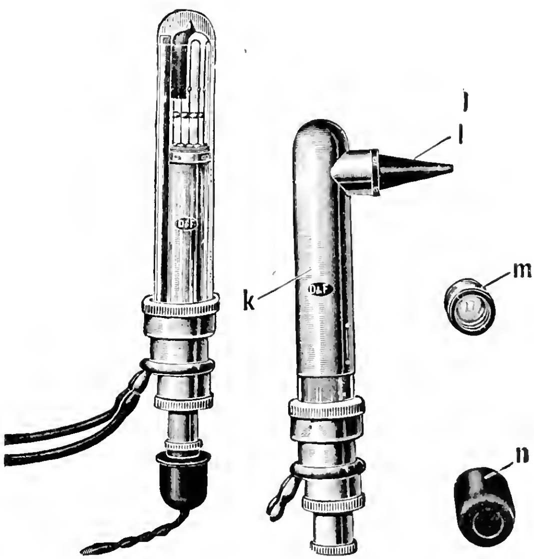
The lamp is silvered at the end so that the light is thrown in a direction upward and backward toward the other end of the instrument. By reason of the concentration and reflection of the light the transillumination value of the lamp is 100 c. p.

For the transillumination of the eye an entirely dark room is neces-

sary and a black face-mask with openings for the eyes must be used over the patient's face.

After the cooling apparatus is working properly, the instrument is placed as high and as far back in the oral cavity as possible, bringing the source of the light back of the soft palate.

The current is now turned on, the pupils of the patient light up and it is possible to see without any practice, pupils, retina and choroid. The observer, to secure the best result, approaches the patient, eye to eye, until their eyebrows almost or quite touch. The observation of hypermetropic cases requires no aid, but if either the observer or



Hertzell's Ophthalmo-Diaphanoscope.

patient is myopic, a concave lens should be held before the examined eye. The maximum illumination, as might be expected, is in the lower angle of the orbit, and for the best results the eye should be caused to rotate by having the patient direct his gaze in certain directions, so that the portion of eye to be examined may be brought into the clearest part of the field. The picture is seen erect, but an inverted image may be secured in the regular way by means of a convex lens. The best illumination is had with the direct image. Enlargement of the pupil is not necessary.

Attention is directed to the fact that in this method there are no

reflections and that an examination can be made without any special preparation.

Wholly or partly opaque foreign bodies are sharply defined and easily located. Employed during the operation for their removal the diaphanoscope is very useful, the field of operation being in no way circumscribed.

Stephenson (*Ophthalmoscope*, Dec., 1908) reports seven cases, including five of intraocular tumor, in which diaphanoscopy correctly indicated the character of the case. In a sixth case a subretinal blood clot gave the appearance of tumor. In a seventh case transillumination made the diagnosis between scleral staphyloma near the equator, and a new growth.

Fridenberg (*Arch. Ophth.*, May, 1908) in general prefers the Würdemann instrument, but the Sachs transilluminator is superior when brilliant illumination is required. He has used the latter to light up the interior of the eye for the ophthalmoscopic examination, especially toward the periphery of the fundus. He has observed the transparency of the iris when denuded of pigment, beautifully demonstrated by transillumination. He finds that corneal opacities have no effect upon the light, the red glow of the pupil being seen through dense leucomas. Würdemann (*Ophth. Record,* April, 1908) calls attention to the value of his instrument for the examination of the eye by oblique illumination. He finds that diaphanoscopy reveals the character of lens opacities; and he publishes sketches of the appearance after pigment absorption and injuries to the iris, and foreign bodies in the lens. He describes the light ring, wrongfully ascribed to the circumlental space, the narrowing of which is a symptom of glaucoma.

Würdemann (*Ophthal. Record*, Mar., 1908; page 112) believes that transillumination assists in the diagnosis of glaucoma in the anterior types. The diaphanoscope is applied to the sclera at the outer canthus. The pupil is lighted up and if the eye be looked at obliquely the ciliary body will appear as a dark ring some few millimeters from the corneal margin, at which another dark ring appears caused by the root of the iris. Between these two rings is an illuminated area which corresponds to the circumlental space. It is usually about 3 or 4 mm. wide. It is enlarged during accommodation. It may be encroached upon or obliterated by changes in the size of the ciliary processes. A family tendency to a narrow circumlental space predisposes toward glaucoma. Diaphanoscopy is negative in posterior glaucoma unless the anterior chamber becomes smaller.

Langenhan (*Zeitschr. f. Augenh.*, Vol. 24, p. 97; *Amer. Jour. Ophth.*, Vol. 27, p. 227) first considers the difficulties in the way of

differential diagnosis between simple retinal detachment and intra-ocular tumors, and then details cases showing the possibilities with the diaphanoscope of Hertzell. In the first case there was a choroidal sarcoma lying at the temporal margin of the papilla. With the diaphanoscope the tumor appeared as a deep-black, well-defined shadow on the otherwise red fundus, while outwardly from the shadow the red light could be seen unimpeded either by the detached retina adjacent to it, or by the second detachment below. The growth was non-pigmented. In the second case there was, with the ophthalmoscope, a flat detachment of the retina beginning down and out from the papilla and reaching forward to the ora serrata, with new-formed connective tissue near the papilla and toward the equator. By diaphanoscopy there was a dense-black shadow in the lower quadrant of the retina. Section showed a flat, darkly-pigmented choroidal sarcoma. The value of the method in the presence of dense vitreous opacities was demonstrated by the diagnosis of an almost unpigmented, round-cell sarcoma with this complication. A fourth case showed its worth in discovering the presence of a small tumor, and a fifth in proving that even in the most dimly-lighted portion of the fundus (upper temporal) a growth could be made out.

Langenhan (*Zeitschr. f. Augenh.*, Vol. 24, p. 512, 1910) further points out that when the ocular fundus is illuminated by the ophthalmo-diaphanoscope of Hertzel placed in the pharynx, the appearance of the fundus is quite different from that seen with the ordinary ophthalmoscope. There is bright-red illumination of the field, against which the disk and larger retinal veins can be made out, but the arteries are not apparent. He has also described and illustrated the rather faint shadow cast by medullated nerve fibers in the retina. The method is of chief value in recognizing a tumor of the posterior segment of the eyeball, which will cast a dark shadow even when unpigmented. Such a shadow is readily perceived through dense opacities of the lens or vitreous, but may be masked by hemorrhage. Golowin (*Viestnik Ophth.*, Vol. 27, Nov., 1910) has also written on retrobulbar illumination of the eyes, which he secured by opening the conjunctiva between the superior and external recti muscles and thrusting the transilluminator back of the eye-ball.

Fridenberg (*Tr. Sec. on Ophth. A. M. A.*, p. 71, 1910) has found that normal iris, whatever its color, or any mass of uveal pigment, is an absolute bar to transillumination. This opaqueness of the iris and ciliary body renders any appearance due to a circumlental space quite impossible. He was able to obtain a marked shadow in leuco-sarcoma,

and to show the position and mobility of the pupil through dense corneal opacities. By combining this method with ophthalmoscopy sufficient illumination is obtained to make a satisfactory examination of the ora serrata and neighboring ciliary region. In a case of chronic scleritis, with marked thinning of the sclera, reported by Stilwell and Sisson (*Ophth. Record,* Vol. 19, p. 392, 1910), transillumination clearly outlined the ciliary body and processes.

Hansell (*Ann. of Ophth.,* Vol. 20, p. 534, 1911) reports that Hertzell's instrument is invaluable in the diagnosis of orbital tumors, thickening of the walls of the orbit, and in growths in the posterior half of the eyeball. Like others who have used it, he finds that the details of the fundus are less clearly seen with it, than when illuminated by the ophthalmoscope. The veins stand out sharply, but the arteries and optic nerve are more difficult to see.

Langenhan (Graefe's *Arch. f. Ophth.,* Vol. 79, p. 61, 1911; *Ann. of Ophth,* Vol. 21, p. 554, 1911) continuing his work with this instrument, has used it as the ordinary transilluminator, applying a special tip to the sclera. He reports that the translucency of the iris depends on its pigmentation and on the size of the pupil. With a contracted pupil the stretched iris permits the passage of more light. With such illumination he could recognize a dark line at the ora serrata, the darker zone of the ciliary body, and the edge of the lens showing on the iris on the side toward the light. In a considerable percentage of normal eyes a defect of pigment in the posterior layer of the iris was found in the lower quadrant. This he considers a rudimentary form of iris coloboma.

The experiments of Rübel (Graefe's *Arch. f. Ophth.,* Vol. 82, p. 317, 1911; *Ophth. Lit.,* Vol. 2, p. 15, 1911) in diascleral transillumination were made with Sachs' lamp which, though much less powerful, stands next to that of Hertzel among transilluminators. He concludes that the transmission of light through the iris varies with the character of the stroma; both the pigmentation and the thickness of the anterior layer being important. No difference in brightness between the upper and lower halves of the iris could be perceived. Its translucency often increases in cataractous eyes from senile atrophy of the retinal pigment layer, and such increased transmission of light gives ground to fear fluid vitreous, which may complicate cataract extraction.

Diaphanotype. A colored photographic positive superposed on a duplicate monochrome print.

Diaphanous. Transparent. Translucent.

Diaphorèse. (F.) Diaphoresis. Sweating.

Diaphoresis. Sweating, in the form of hot baths, has been frequently referred to as an adjuvant in the treatment of ophthalmic diseases. See, for example, Vol. II, page 910, of this *Encyclopedia.*

A. Brav (*American Medicine*, Feb., 1910) considers the Russian vapor baths and the Turkish hot-air baths the most convenient and effective means to produce active diaphoresis. In diseases due to scrofulous, rheumatic, and luetic conditions he believes diaphoresis of great value, also in toxic amblyopia. He says that the beneficial influence upon ocular processes is accomplished, by enhancing and readjusting metabolic changes and in removing metabolic end-products and in eliminating deleterious toxic substances from the organism, by the re-establishment of the equilibrium in the general circulation, by the removal of possible venous stasis, by the purification of the blood itself, by the elimination of circulating toxins, following the stimulation of the sweat glands and the direct effect upon the vascular system. There is a further invigoration of the peripheral and central nervous system, thus increasing the nutrition of the ocular tissues affected. It also acts upon the lymphatics, stimulating absorption and thus carrying off the inflammatory products of the diseased parts of the eye. Finally, there is the local, stimulative effect of moist heat so important to the tissues and so essential to the various inflammatory processes of the eye.

Wood and Anderson (*Ophthalmoscope*, XI, p. 347, 1913) enthusiastically recommend the use of guaiacol diaphoresis in ophthalmology. Their routine is to prepare the patient overnight by administration of an aperient; in the morning after a very hot bath to put the patient to bed between blankets with hot-water bottles, and to apply over the epigastrium an average dose of two drams of a pigment made of equal parts of guaiacol and olive-oil, smeared on a piece of lint six inches square, the whole being covered with oiled silk and fixed in place with adhesive strips. The treatment was usually combined with the administration of mercury and potassium iodid, or at times the salicylates. The chief conditions in which the treatment was used are retrobulbar neuritis, papilledema, vitreous opacities, chronic iridocyclitis, non-ulcerative keratitis, and various syphilitic manifestations.

The employment of sweating as an excellent and effective adjunct to the internal administration of pilocarpin, iodides, salicylates, aspirin, etc., should not be forgotten.

Diaphragm. Diaphragm opening. In *optics*, a ring or plate with a circular hole centrally placed upon the axis of an optical instrument to exclude peripherally incident and extraneous rays of light.

Of a microscope, a perforated partition, usually in the form of a circular plate pivoted at its centre to the stage and having a number

of circular perforations of various sizes so arranged that, by turning the plate on its pivot, the centre of any one of them may be made to coincide with the central axis of the instrument; used to regulate the amount of light admitted to the object under examination.

Diaphragma bulbi. An ancient name for the iris.

Diaphragmal. Diaphragmatic. Pertaining to a diaphragm.

Diaphragm iris. A device for changing or regulating the amount of light directed upon an object under the microscope.

Diaphragm test, Harman's. This test is the reverse of Javal's well-known "bar-reading" test. (See Vol. II, p. 884 of this *Encyclopedia.*) Instead of a bar, which the patient's eyes must negotiate, there is a screen with a single hole in it; through this hole the patient can look with both eyes quite naturally and without suspecting the test to which his vision is being subjected.

The instrument is made of wood, like a flat ruler, 44 cm. long, fitted with a rack at one end to receive the test cards, and a screen measuring 9x6 cm. fixed at 11 cm. from the rack. In this screen, or diaphragm, two holes are cut, one 1.7 cm., square; the other, round, 1.7 cm. diameter. In making tests either the square or round opening may be employed. A movable pin is fixed to the diaphragm so that it can be projected into the opening as a point of fixation in certain experiments. A handle is fixed beneath the base-board.

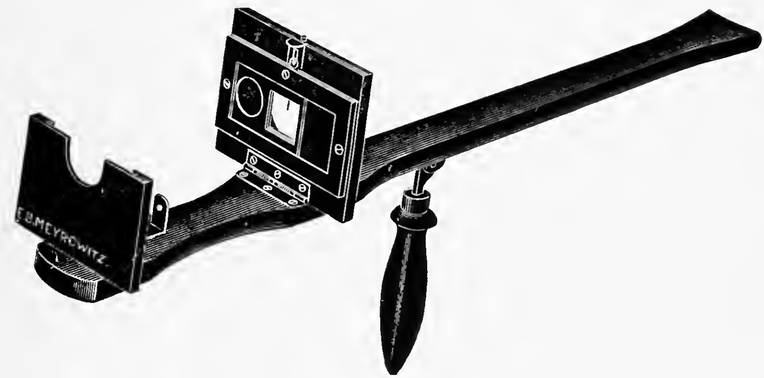
In use the patient takes hold of the handle with both hands and places the free end of the rule (this is washable) against the upper lip, just beneath the nose. The operator stands facing his patient and holds the other end of the instrument to keep it steady. When the instrument is in position the patient is asked to look either through the hole or at the pointer projecting into it, according to the test desired, and to tell what he sees through the hole.

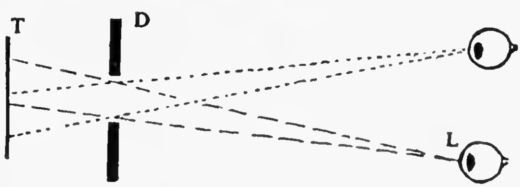
The test cards used in the instrument are of three kinds: (1) Printed matter of any size from diamond in set paragraphs to canon in paired capitals. (2) Black or colored squares variously disposed. (3) Pictures for children. A number of test cards are issued with the instrument, but the surgeon can make and vary them indefinitely.

The screen with the square hole is most generally useful for reading tests particularly, and when we wish to demonstrate the presence of binocular vision where it is denied. When the patient looks clear through the hole at the test the margins of the hole are seen doubled, the square becomes an oblong; this change escapes remark save by the most observant. On the other hand, when it is desired to demonstrate weakness of binocular vision or in fusion experiments, the round hole

is the better, as reduplication of the circle and overlapping of the two images is very noticeable.

The test is of value for the following purposes: (1) To determine the equality of visual acuity in the two eyes. (2) To determine the presence, the absence or a defect of binocular vision. (3) To exercise the vision in squinting eyes. (4) To detect malingerers feigning monocular blindness. (5) To demonstrate certain physiological phenomena connected with the perception and suppression of images.





Bishop Harman's Diaphragm Test.

Diaplégie. (F.) Progressive general paralysis.

Diapositive. A positive made from a negative.

Diapyesis oculi. (L.) An obsolete term for hypopyon.

Diascope. A glass plate pressed against the skin for observing the underlying anatomic changes other than those of congestion.

Diaspasme. (F.) Tear. Rent. Distortion.

Diasphyxie. (F.) Arterial pulsation.

Diaspirin. A substitute for *aspirin* (q. v.) and used, like it, in the same dosage for numerous ocular disorders, especially those of rheumatic, gouty and unknown origin. To produce diaphoresis Sylla uses 1 gm. doses of diaspirin, given with hot drinks one and one-half hours apart, the second followed by a hot foot-bath, and heavy

woolen covering. He finds diaspirin less likely to disturb the heart action than aspirin. See **Aspirin,** Vol. I, page 643 of this *Encyclopedia.*

Diät bei Augenleiden. (G.) Dietetics in ocular diseases.

Diatessadelton. (L.) An ancient name for mercuric bichloride.

Diathermal. Diathermanous. Diathermic. Diathermous. Readily permeable by heat rays.

Diathermance. Diathermancy. Diathermaneity. Transparency or permeability to radiant heat, or other form of energy.

Diathermanism. Diathermia. The transmission of radiant heat, or similar form of radiant energy.

Diathermometer. An instrument for the measurement of diathermancy.

Diathermy. Diathermia. A method of raising the body temperature, locally, by means of heat, especially in conjunction with high frequency currents.

A. Vogt (Graefe's *Archiv f. Ophthalm.*, 83, p. 99, 1913) experimented, in measuring the diathermancy of the human eye and eyelid, with five human eyes, and the tarsal part of one upper lid. The tests were made with a thermopile and an Engelmann galvanometer. From 20 to 25 per cent. of the rays falling on the cornea from a carbon filament lamp reach the anterior chamber. About the same proportion of rays pass through the sclera. Through the tarsal part of the upper lid pass 6 per cent. of the rays falling upon it. About four-fifths of the rays passing into the globe are dark and belong to the ultra-red. Glass protects against long-waved, but not against short-waved, ultra-red radiations. A pupil reaction cannot be produced with the ultra-red, although it does result from the passage of sunlight or incandescent electric light through the lids or the anterior part of the temporal wall of the orbit. The higher the temperature of sources of light the more short-waved ultra-red rays they contain. Higher intensities of long-waved ultra-red were demonstrated to have a toxic action on the external parts of the eye, and the same was true of the effect of short-waved ultra-red on the iris.

The *Ophthalmic Year-Book* has abstracted still more recent literature on this subject, as follows: At the Tübingen clinic diathermia has been obtained by the high-frequency current, which by the resistance of the body tissues is converted into heat. Placing the electrode on the closed lid of the eye of a rabbit, the temperature in the conjunctival sac was raised to 42° C. in about six minutes. Microscopic examination of the eyes showed no injury to any part. When the temperature was raised to 45° C. or upward, inflammatory swelling of the lids and diffuse

clouding of the cornea occurred. The temperature of the vitreous at the end of ten or twelve minutes was found increased rather less (0.7 to 1.6° C.) than in the conjunctival sac, and approximately the same effect was noted in the orbit. Zahn (*Klin. Monatsbl. f. Augenheilk.*, Apr., 1912, p. 371) concludes that a temperature of 39° C. in the conjunctival sac may very well be maintained by this means in case of ocular or orbital inflammation, since this temperature is found merely agreeably warm by most persons. From the same clinic Clausnizer (*Klin. Monatsbl. f. Augenheilk.*, June, 1912, p. 755) reports that diathermia increased in some inflammatory conditions.

Sattler's experiments (*38th Ophth. Cong.*, Heidelberg, p. 379, 1911) on the practical effect of diathermia on the eye show that it increases the proportion of albumin in the aqueous. The normal aqueous contains 1/40th of 1 per cent. of albumin. By heat applied to the lids in the ordinary manner, raising the temperature to 55° C., the proportion of the albumin was raised to one-fourth of 1 per cent. But with diathermia 1 per cent. of albumin appeared in the aqueous.

Aubaret (*Arch. d'Opht.*, Vol. 32, p. 39, 1911) reports his experience with the hot air douche. The current may be directed either against the closed lid or upon the exposed portion of the eyeball. If the temperature is moderate the sensation is first one of pleasant warmth, gradually passing into burning as the tissues become heated. The sittings last five or ten minutes. Intractable chronic blepharitis seemed to be favorably influenced. Rapid improvement occurred in phlyctenular and ribbon keratitis. In scleritis and inflammation involving the iris pain was quickly relieved. Krückmann (*37th Ophth. Cong.*, Heidelberg, p. 16, 1911) has applied diathermia to the treatment of rheumatic iritis, but finds it difficult to raise sufficiently the temperature of the eyeball without causing coagulation and burning of the skin of the lids. Pich (*Cent. f. prak. Augenheilk.*, Vol. 35, p. 367) has treated corneal ulcers and iris inflammations by poultices, believing this secures better transparency of the media and relieves pain.

Diathesis, Hemorrhagic. See **Hemophilia in ophthalmic surgery**; also **Coagulose,** page 2300, Vol. III, of this *Encyclopedia.*

Diatom prism. A form of prism used in microscopy, which gives the most suitable light for observing very fine lines or markings.

Diazo tests. Urochromogen test for tuberculosis. Schäfle (*Journal A. M. A.*, Oct. 10, 1914), has used this test of Weiss in Tuberculosis State Dispensary No. 21, and later extended his observations to the Philadelphia General Hospital. The positive reactions are much more numerous with this test than with the diazo and the significant features are the difference in mortality percentage between the positive and

negative cases and particularly the high death rate among the tuberculous with the negative diazo and a positive urochromogen. The technic of Weiss, he says, requires a small amount of limpid urine diluted with water to three times its volume, divided between two test-tubes, to one of which three drops of a 1:1,000 dilution of potassium permanganate is added, the other tube being used as a control. Schäffle recognizes as a positive reaction only a distinct canary-yellow, fairly permanent, though there were frequent slight yellow reactions which soon disappeared. He has also used the test with urine from patients with diseases giving the diazo-reaction but the results are insufficient for comparison. In normal individuals he always found it negative.

Dichotomy. One of the terms of teratology used to indicate a bifurcation or division of organs into one or more pairs; as in supernumerary fingers and toes. When it affects the head it is called *anterior dichotomy;* when the lower extremities, *posterior dichotomy.* Thus, to the former class belong double-headed monsters with four eyes.

Dichroic. 1. Characterized by dichroism; as, a *dichroic* crystal. 2. Same as *dichromatic.*

Dichroism. In *optics,* (a) A property possessed by doubly-refracting crystals of exhibiting different colors when viewed in different directions. Thus palladium chlorid appears of deep-red color along the axis, and of vivid-green when viewed in a transverse direction. Mica affords another example, being nearly opaque when viewed in one direction, but transparent and of different color in another. This property is due to the difference in the absorption of the light-vibrations in the different directions. (b) The exhibition of essentially different colors by certain solutions in different degrees of dilution or concentration.

Dichroistic. Dicroous. Having the property of dichroism.

Dichromasia. Dichromic vision. Daltonism. Dichromism. An abnormal condition of the color sense in which, instead of the great variation seen by the normal eye in the spectrum, only two colors are perceived, yellow, and blue. This is the most common type of dyschromatopsia. The English chemist Dalton was himself affected with this abnormality and was the first to accurately describe it. The theory of color-perception and its evolution propounded by Edridge-Green (*Lancet,* Feb. 4, 1911, pp. 285, 358; *Brit. Med. Jour.,* Feb. 11, 1911) is the basis for his classification of color-blindness. It is quite different from the older classifications, and more closely in accord with the physics of color as revealed by the spectroscope. Corresponding to the original evolutionary stage of simple light perception, we have complete color-blindness; in which the whole visible spectrum

appears of one color. Next comes dichromic color-vision, in which the most widely separated colors—red and violet—are seen to differ, while between them lies a neutral shade of gray. The red includes yellow, the violet includes the blue part of the spectrum. The dichromics include the worst cases of "green-blindness" of the older classifications. Next the trichromic perceives three colors—red, green and violet. The color-blind of this class, with the dichromics, constitute the dangerous color-blind; both because of the rudimentary state of their color discrimination, and because of their uncertainty about red and green used for signals. Persons with lesser degrees of color-blindness are classed as tetrachromics who, in addition to the three colors of the trichromic, perceive yellow. Pentachromics also perceive blue as a separate color, and hexachromics distinguish orange. This class includes the majority of persons ranked as having normal-color-vision, but many can perceive a seventh distinct color, indigo, between the blue and violet. These are classed as heptachromics. But in addition to inability to distinguish between the different colors the spectrum may actually appear shortened at either end, so that red light of a certain hue, or the violet, is actually invisible. This leads to a shifting of the zones in the spectrum that are discriminated; and the failure to receive any impression from the red or violet light that may be present in a mixed color, causing the color to appear darker.

With this conception of color-blindness Edridge-Green has discussed the various color-tests which aim at the practical exclusion of the dangerous color-blind. It is necessary that these should indicate persons who see only three colors, or less, in the spectrum, those who have shortening at the red end of the spectrum so that red lights appear very dim, or cannot be seen at all as well as those who are unable to discriminate between red, green and white, when the retinal image is comparatively small, or the illumination deficient. The color-blind find it difficult to remember colors, and easily become confused with regard to them. They are more at the mercy of color-contrast, and of illumination. Some who match colors correctly in a good light are still unable to classify them by name. But this they must do in order to appreciate the significance of signals called red or green.

Stargardt and Oloff (*Zeit. f. Augenheilk.*, Vol. 28, p. 1, 1911), although they do not mention the theory of Edridge-Green, emphasize some of the important facts upon which that theory is based. They point out the obstacles that the Young-Helmholtz theory places in the way of understanding color-blindness as actually encountered; that the dichromics see the spectrum very much like the completely color-blind; that the distinction between green- and red-blind is confusing

rather than helpful; and that all grades of defect in color-vision may be found, running from complete absence of color discrimination to perfect color vision.

Hilbert (*Klin. Monatsbl. f. Augenheilk.*, Mar., 1912, p. 279) would classify disturbances of color sensation according to their origin, as: 1. Physical, including color interference, chromatic polarization, phosporescence, fluorescence, and pigment colors. 2. Physiologic color sensation produced by contrast, simultaneous or successive, electrical stimuli, etc. 3. Pathologic sensations, as those due to irritation and other disturbances of the center for color, and including congenital or acquired color-blindness, so-called. Köllner (*37th Ophth. Cong.*, Heidelberg, p. 245, 1911) has studied the distinction between normal and subnormal color-sense, discussing the conclusions reached by others, and especially the applicability of Rayleigh's equation. See, also, **Color-sense and color-blindness.**

Dichromatic. Having or pertaining to two colors; exhibiting or characterized by dichromatism.

Dichromatic systems. Two color sensations are possessed by most color-blind people. They see two colors, complementary to each other; vision of intermediate or mixed colors is lacking. The red end of the spectrum is seen as one color, the violet end as the other; these terminal ends can be distinguished from a neutral zone located in the green-blue portion of the spectrum. By means of yellow and blue an individual with dichromatic vision can represent every color.

Dichromatism. The quality of being dichromatic; the state or condition of normally presenting two different colors or systems of coloration.

Dichromatopsia. A form of color-blindness in which only two of the primary colors can be distinguished.

Dichromic. Relating to or embracing two colors only; bichromatic: used by Herschel to describe the vision of a color-blind person who lacks the perception of one of the three primary colors assumed in accordance with the Young-Helmholtz theory of color.

Dichromism. Dichromatopsia. The same as dichromasia.

Dichroous. Dicrous. 1. Same as dichromatic. 2. Same as dichroistic.

Dichroscope. An instrument for testing the dichroism of crystals, usually consisting of an achromatic double-image prism of Iceland spar, fixed in a brass tube which has a small, square hole at one end and a convex lens at the other, of such power as to give a sharp image of the square hole. On looking through the instrument the square hole appears double, the light which passes through being divided into two rays polarized in planes at right angles to each other; and if a dichroic

crystal is placed in front of it, the two images, corresponding to the two sets of light-vibrations, will appear of different colors. A dichroscope may be combined with the polarization apparatus of a microscope. —(*Century Dictionary.*)

Dichroscopic. Pertaining to the dichroscope: as dichroscopic observations.

Dichtigkeit. (G.) Density. Solidity.

Dickes Augenfell. (G.) Pterygium crassum.

Dickinson, William. A pioneer of American ophthalmology. The date and the place of his birth are unknown. He received his medical degree at Harvard University in 1851. He then spent nearly five years in Germany, where he studied with Sichel, Desmarres, Arlt, Jaeger, and von Graefe.

In 1857 he settled in St. Louis, where he practised and taught ophthalmology. At the outbreak of the war he was commissioned Brigadier Surgeon of the U. S. A., and served in this capacity for some time. After the war, he re-established himself in St. Louis, and became very prominent. He was active in society work, and became connected with several hospitals as ophthalmologist.

His most important services to ophthalmology were rendered in the course of his long-continued but always unsuccessful, efforts to secure the establishment by the legislature of a State Eye and Ear Hospital. For eleven years (1861-72) he labored unceasingly toward this end. His Eye and Ear Hospital bills were always defeated, though, as a rule, by a very narrow majority. In the course of his efforts to secure the passage of these bills, he accumulated an enormous amount of information, statistical and other, and, at his death, he left to a friend his collection of books, documents, and papers, with the earnest request that the work should be carried on until it was successful.

Jan. 24, 1894, he left St. Louis for California, in search of health. So utterly exhausted, however, was Dickinson before he started on this long and tiresome journey, that he died only a few days after he had reached the land from which he had hoped so much.—(T. H. S.)

Dicochirurgea. An obsolete term for forensic surgery.

Dicodeine. An amorphous base, $C_{72}H_{84}N_4O_{12}$, a polymeride of codeine, and formed from it by the action of phosphoric or sulphuric acid. Administered to animals, it produces dilatation of the pupils, vomiting, and diarrhea, without the cerebral congestion and supersensitiveness following upon the administration of codeine.—(Foster.)

Dicrocoelium oculi humani. A trematode parasite. See **Distoma.**

Dictyon. (L.) An ancient name for the retina.

Dictyopsia. (L.) A morbid condition in which the patient seems to see net-like objects before the eyes.

Dictyoschisma. (L.) A term applied by Hirschberg to coloboma of the choroid.

Dictyosie. (L.) The formation or presence of black specks in the vitreous humor of the eye.

Didymine. This testicular substance, marketed by Burroughs, Welcome & Co. in 5 grain tablets, has been prescribed with effect in Basedow's disease and by Dor for asthenopia in children when complicated by unduly rapid growth.

Didymum. In 1909, a new glass (having a peculiar salmon-pink reflection and a slatey color when seen by direct light) was discovered in Germany. It was given this name because it derived its peculiar color from the presence of the salts of the metal didymum.

Dieffenbach, Johann Friedrich. A famous general surgeon of Berlin, of the early 19th century, who should be regarded as the founder of plastic surgery, and who invented the strabismus operation. Born Feb. 1, 1792, at Königsberg, Prussia, he lost his father at a very early age. In 1812 he studied theology at Rostock and Greifswald. For the next two years he was engaged in voluntary military service. From 1816-20 he studied medicine at Königsberg. Here he showed decided aptitude for surgery and anatomy, and, on his own account, engaged in a series of attempts at the transplantation of hairs and feathers. He had just obtained a prosectorship, when, as a consequence of a love affair with a married woman, Johanna Moterby, he was obliged to leave the city. Going to Bonn, he received, on the recommendation of the powerful von Walther, a commisison to escort to Paris, in his capacity as physician "a sick, blind, Russian lady, the widow of Rostoptschin, the burner (in 1812) of Moscow." In Paris he formed the acquaintance of Boyer, Dupuytren, Larray, and Magendie. Then for a time he studied with Delpech and Lallemand at Montpellier. Returning to Germany, he received his medical degree at Würzburg, presenting the dissertation, "*Nonnulla de Transplantatione et de Regeneratione.*"

Most of the movements of his life would seem to have been controlled almost absolutely by the aforesaid married lady, Johanna Moterby, who, at length, had secured a divorce from her husband and married Dieffenbach.

In 1823 Dieffenbach settled in Berlin. Here he would seem to have had some difficulty at first in establishing himself in practice. Success, however, at length was his, and his popularity may readily be

imagined from a song which the children of Berlin were wont to sing about the streets:

"Wer kennt nicht Doctor Dieffenbach,
Den Doctor der Doctoren?
Er schneidet Arm' und Beine ab,
Macht neue Nas' und Ohren."

He was always a brusque and energetic man, quick and quick-tempered, but quicker still to seek pardon and to grant it; talkative, genial, given to much praising, warm of heart and generous beyond all bounds. Add to these social qualities the highest possible degree of surgical inventiveness, a hand so quick and accurate as to be a marvel and almost a mystery, and, still further, a brilliant and fiery eloquence—and you have Dieffenbach, the idol of all his patients, of all his students, of all the faculty, and, in short, of everybody.

He died Nov. 11, 1847, when about to enter and perform an operation.

Dieffenbach has well been called "the creator of plastic surgery." The ancient Assyrians and Babylonians, and the ancient Egyptians, alike knew nothing of the subject. The ancient Greek and Romans knew very little more. Susruta, the Indian, describes the so-called "Indian operation" for the restoration of a nose, as follows: "When anyone's nose has been cut off" [a common punishment in those days] "let the physician cut a leaf of the same size from a tree, lay it upon the cheek and cut therefrom a piece of skin and flesh of that size, but in such a way that it remains attached in one place. Sew up the cheek with needle and thread, freshen the stump of the nose, turn over upon it quickly, but with care, the loosened skin, apply an appropriate dressing and sew the new nose in place." The Arabs would seem to have done no plastic surgery at all. The Italian method of rhino-plasty (as invented and practised by Antonius Branca, *q. v.*) consisted in taking the needed tissue from the arm (early 15th century). In 1814-15, Carl Ferdinand von Graefe practised the Indian method with certain modifications, but it remained for the brilliant Dieffenbach to become indeed the "Father of Plastic Surgery."

It would lead us far astray to enter upon a discussion of the achievements of this man in the field of general plastic surgery. We will therefore merely remind ourselves of his ingenious and valuable "blepharoplasty," which is still extensively employed and described in detail in the non-historical portions of this *Encyclopedia.*

This remarkable man should also be remembered as the inventor of the strabismus operation. Before this time, cross-eyes were treated, or mistreated, by means of mere masks, bandages, and similar forms

of ineffectiveness. Louis Stromeyer, professor of surgery at Hanover, in 1838 proposed the employment of muscular section as a means of treating cross-eye, and he even went so far as to perform the operation on a cadaver. But Dieffenbach, in 1839, reported the case of a boy of seven on whom he had actually performed this operation for an inward squint, in the presence of Jüngken, and with an almost perfect result. Dieffenbach was also exceedingly active, later, in perfecting the technique of his new operation. In 1814 the Paris Academy of Sciences divided the Monthyon prize between Stromeyer and Dieffenbach: "To M. Stromeyer for having first proposed and performed the strabismus operation on the cadaver, and to M. Dieffenbach for having first performed the operation with success on the living subject."

Dieffenbach's most important writings are as follows:

1. Die Abgeänderte Umschlungene Naht als Schnelles Heilmittel bei Gesichts-Wunden. (J. Hecker's *Literar. Annalen f. d. Ges. Heilkunde*, Bd. 8, S. 129, Berlin, 1827.)
2. Neue Heilmethode des Ectropium. (J. N. Rust's *Magazin f. d. Ges. Heilkunde*, Berlin, 1830, S. 938.)
3. Fall von Blepharoplastik. (v. Ammon's *Zeitschrift*, Bd. IV, S. 438.)
4. Beitrag zur Verpflanzung der Hornhaut. (v. Ammon's *Zeitschrift*, Bd. 1, 2, S. 172-176, 1831.)
5. Beiträge zur Subkutanen Orthopädie. (Casper's *Wochenschrift*, 1839, No. 38.)
6. Chirurgische Erfahrungen, Besonders über did Wiederherstellung Zerstörter Theile des Menschlichen Körpers nach Neuen Methoden. (Drei Bd., Berlin, 1827-34.)
7. Ueber Schiel-operation. (Leipzig, 1845.)
8. Der Aether gegen den Schmerz. (Berlin, 1847.)—(T. H. S.)

Dieffenbach's operation. For blepharoplasty; a quadrangular flap is taken from the cheek. See page 1070, Vol. II, of this *Encyclopedia.*

Dietetics, Ophthalmic. The question of feeding patients, in other words, the whole matter of ophthalmic dietary, although of great importance, is generally undertaken by the family physician. Nevertheless, it is important that the ordinary rules of dietetics should be studied as a part of the equipment of every ophthalmologist. There is, however, a section of dietetics that every surgeon must consider, because it is of much importance in the conduct of operative cases. It is proposed to say a few words about this particular matter and to refer the reader for information regarding general dietetics to **General diseases,** where the subject is discussed in detail.

Regarding post-operative dietetics we are not confronted with such

problems in ophthalmic patients as are met with in abdominal operations, for instance, and the question is, on the whole, simple. If the patient has taken a general anesthetic, no food or drink should be given until the stomach is quiet and the nausea and vomiting have ceased. The stomach can then be tested with a teaspoonful of ice water, and if this is retained, water may be more freely given, as well as milk, broths, etc. Solid and semi-solid food should be withheld for twenty-four hours. After that time, or from the completion of the operation if a general anesthetic has not been required, the patient should be put on a light diet, such as milk, cereals, eggs, soup, etc., with a few vegetables, and little or no meat, until he resumes his usual activity. In case the operation has involved the interior of the eye-ball, food that requires much chewing is usually to be avoided until the wound in the ball has closed, since the motion of chewing may disturb the eye and lids a little. Except for such precautions as are usually taken in the way of avoiding articles known or apt to cause gastro-intestinal derangement, and in the temperate employment of all kinds of food, the question of a post-operative dietary calls for no special consideration.

A question one is often called on to consider is that of the use of tobacco and alcohol after operations on persons addicted to their use. This decision should largely rest upon the amount of disturbance their withdrawal is likely to produce. If the craving is great, it is better to allow the stimulant and let it be used openly, safely and moderately, than, as may be the case, secretly, immoderately and in a clumsy or otherwise unsafe manner. The same may be said of the use of narcotic drugs by patients who are habituated to them.

Diethylglycocollguaiacol hydrochloride. See **Gujasanol.**

Differential refraction. Astronomical refraction to which is due a change in the apparent relative position of two objects.

Differential staining. A method of staining—especially various bacilli—which takes advantage of the fact that if deeply-colored, with a mordant, they retain the color in the presence of certain reagents that decolorize the surrounding tissues. Koch, Ehrlich, Weigert and Gibbes, for example, have devised various methods of differential staining.

Differential thermometer. A thermometer for measuring differences of temperature.

Difform. Irregular in form. Dissimilar.

Diffraction. In *optics*, the spreading of light or deflection of its rays, accompanied by phenomena of interference; occasioned by the neighborhood of an opaque body to the course of the light, as when it passes by the edge of an opaque body or through a small aperture, the luminous rays appearing to be bent or deflected from their

straight course and mutually interfering with one another. See **Interference.** Thus, if a beam of monochromatic light is passed through a narrow slit and received on a screen in a dark room, a series of alternating light and dark bands or fringes is seen, which diminish in intensity and distinctness on either side of the central line; if white light is employed, a series of colored spectra of different orders is obtained. Similar phenomena of diffraction are obtained from diffraction gratings, which consist of a band of equidistant parallel lines (from 10,000 to 30,000 or more to the inch), ruled on a surface of glass or of polished metal; the spectra obtained by this means are called *interference* or *diffraction spectra.* They differ from prismatic spectra, since in them the colors are uniformly distributed in their true order and extent according to their difference in wave-length; while in the latter the less refrangible (red) rays are crowded together, and the more refrangible (blue, violet) rays are dispersed. Diffraction gratings are now much used, especially in studying the solar spectrum. The best gratings are ruled on speculum metal with a concave surface (often called *Rowland gratings,* after Prof. Henry A. Rowland, of Baltimore), and give an image of the spectrum directly, without the intervention of a lens. (*Century Dictionary.*)

Diffraction grating. A strip of glass or metal closely ruled with fine lines; it is often used in the spectroscope in the place of the battery of prisms. See **Diffraction.**

Diffraction, Ocular. Ciliary corona. See page 2235, Vol. III of this *Encyclopedia.*

Diffraction plate. A grating formed of alternately long and short parallel lines. See **Diffraction.**

Diffraction spectra. See **Diffraction.**

Diffraction spectroscope. A spectroscope in which the prism is replaced by a diffraction grating.

Diffractively. In a diffractive manner.

Diffrangibility. Susceptibility to diffraction.

Diffrangible. Capable of being diffracted.

Diffuse amacrine cells. Spongioblasts. These are elements of the mammalian retina and have been studied by both Dogiel and Cajal. The latter believes that there are two types of amacrines, diffuse and stratiform.

Diffused light. The light from the sun that has been scattered or irregularly reflected by impinging upon terrestrial objects, including fine particles of dust in the atmosphere.

Diffuse dots in the retina. TAY'S CHOROIDITIS. GUTTATE CHOROIDITIS. See page 2144, Vol. III of this *Encyclopedia.*

Diffuse keratitis. See **Keratitis parenchymatosa.**

Diffusion circles. BLUR-CIRCLES. Luminous circles, such as thrown upon a screen by a lens when the object is either too far or too near to be in exact focus; or upon the retina when it is not conjugate to the object viewed. See page 2255, Vol III of this *Encyclopedia.*

Diffusion de la lumière. (F.) Diffusion of light.

Diffusione della luce. (It.) Diffusion of light.

Diffusion of light. The irregular reflection of light-rays from the surface of an unpolished surface or body. Some of the rays falling upon such a body are absorbed; others are reflected in every direction, the wave-length of the rays that are so reflected determining the color of the body. The general diffused brightness of daylight is due to the diffusion of light falling upon clouds, particles floating in the air, and bodies on the earth's surface.

Diffusitivity. The capacity or rate of diffusion.

Difteria. (It.) Diphtheria.

Digallic acid. See **Tannin.**

Digestive organs, diseases of the, Ocular lesions in. See **General diseases.**

Digitalin, Oculotoxic effects of. OCULAR SYMPTOMS OF DIGITALIS POISONING. This powerful and poisonous drug is obtained from *Digitalis purpurea* (purple foxglove). It is generally a mixture of several alkaloids, notably digitalin, amorphous digitonin and digitaleïn. It is a yellowish-white powder, soluble in water and alcohol. The dose is from one-tenth to one-half a grain. Although this drug has been recommended as a miotic, yet it is a very unreliable agent for that purpose and has long been discarded. It is occasionally used in the treatment of eye diseases, and has been recommended in ischemia of the retina and in chronic retrobulbar neuritis for its quickening effect upon the circulation. For this reason, also, it has been used in tobacco and quinin amblyopia and amaurosis.

Apart from contracted pupils the oculo-toxic effects of digitalin are by no means constant. Colored vision—especially yellow and green vision—has been several times observed, while a toxic, temporary amblyopia and disturbance of sight have been reported in several cases. See **Toxic amblyopia.**

Digitoxin. (G.) As mentioned under *digitalin* this is often one of the constituents of that compound. It is a weak and unreliable miotic, and possesses most of the other qualities of digitalis.

Dihedral. Two-sided; formed by or having two plane faces; as a

dihedral angle, or a *dihedral* biplane, as the first V-shaped Santos-Dumont flying-machine. This adjective is also used to describe, for example, the stereoscope (q. v.) of Pigeon, an instrument devised for the detection of central scotomata.

Dihybridism. According to the Mendelian theory this is the term applied to cases in which the parents when crossed differ from one another in two pairs of alternative characters. It was found by Mendel that in such cases the inheritance of each pair follows the same rule, but follows it independently. Tallness in the pea is dominant to dwarfness, and color in the flowers is dominant to white. When, therefore, a tall colored is crossed with a dwarf white all the offspring are tall plants with colored flowers. In the next generation talls and dwarfs appear in the ratio 3:1, and coloreds and whites also appear in the ratio 3:1. Hence each tall plant has three times as many chances of being colored as of being white. Similarly the dwarf coloreds must be three times as numerous as the dwarf whites.

Diiodoform. TETRAETHYLENE IODIDE. $C_2H_2I_4$. This substance forms fine, yellow, odorless needles. It is obtained from acetylene iodide by excess of iodin, and contains 95.28 per cent. of iodin. It is soluble in chloroform, benzene and carbon bisulphide; it melts at 192°C., and decomposes on exposure to light. Its use in ophthalmic surgery is as a substitute for iodoform.

Diiodohydroxypropane. See **Iothion.**

Diiodosalicylic acid. See **Sanoform.**

Diktyoma. An expression proposed by Fuchs for a tumor of the ciliary (body) epithelium, having the structure of the embryonic retina. See **Ciliary body, Tumors of the.**

Dilaceration. A tearing apart; generally used to describe division of a membranous cataract by tearing it apart, it may be with two needles; hence the "double-needle operation." This word is also written *dislaceration.*

Dilatability. DILATANCY. Capability of expansion.

Dilatable. Susceptible of expansion or dilation.

Dilatant. Expanding or assuming a state of dilatation.

Dilatation-reflex. RELAXATION-REFLEX. Jessop proposed these terms to describe the condition present when the pupil has been contracted through light accommodation or convergence and the stimulation has been withdrawn. At this stage the normal pupil will return to the size it presented before the stimulus was applied.

Dilatatores canaliculorum lacrimalium. (L.) Muscular fibres (of

Horner) which surround the lachrymal canals, supposed to increase their lumen by their action.

Dilatator inferior sacci lacrimalis. (L.) Tensor tarsi.

Dilatator iridis. DILATATOR PUPILLÆ. DILATOR PUPILLÆ. The radiating non-striated muscular fibres of the iris by which the pupil is dilated. A number of the more recent text-books speak of the dilator muscle of the pupil as an undoubted and definitely proven entity and give illustrations of it. Such drawings and descriptions, Alt (*Am. Jour. of Ophthalm.*, Sept. 1907) believes, probably do not represent its true relations. According to Henle and others, this limiting membrane consists of unstriped muscular fibres, while their antagonists, Gruenhagen, Fuchs and others, describe it as a structureless vitreous membrane with elastic properties, or as a tissue midway between elastic and connective tissue. The writer concludes, from his own studies of the parts, that if what has been seen and described is the musculus dilator pupillæ, it appears that it is rather a weak one when compared with the sphincter pupillæ. It seems probable, therefore, that its action is enhanced by the contraction of the iris arteries and, perhaps, by the relaxation of the sphincter muscles whenever dilation of the pupil takes place.

See, also, Vol. 1, page 385 of this *Encyclopedia;* as well as, **Histology of the eye.**

Dilation of the pupil. This is a reflex act which is brought about normally (1) when stimulation of the retina is diminshed or absent, as in passing from a brightly-lighted to a dark room; and (2) when the eye is directed toward distant objects. Abnormally, contraction occurs in poisoning by some drugs, in certain nervous diseases, and in certain pathologic conditions of the eyeball.

Constriction of the pupil is brought about by the action of the circular muscular fibres found in the pupillary margin of the iris. Dilation is an action whose exact mechanism is still a subject of debate. Some physiologists hold that it is simply a negative act: that, when the sphincter pupillæ relaxes, the elastic radiating fibres of the iris cause the enlargement; while others claim the existence of special dilating fibres.

Contraction of the pupil in response to the stimulus of light falling on the retina is a reflex act, the optic being the afferent nerve, the motor oculi the efferent path, and the centre being situated in the floor of the aqueduct of Sylvius.—(J. M. B.)

Dilative. Tending to dilate. Causing dilation.

Dilatometer. An apparatus making use of interference phenomena to determine thermal expansion.

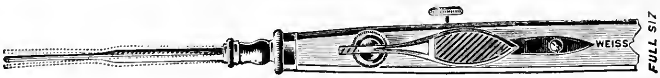
Dilator, Bell Taylor's canaliculus. This olive-pointed instrument is

intended to be introduced through a punctum and then carried along the small lachrymal canal. See the figure.

Bell Taylor's Canaliculus Dilator.

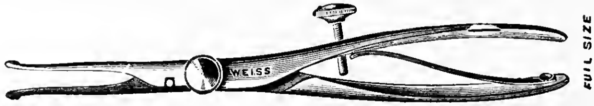
Dilator, Blitz's lachrymal. This instrument for the relief of stricture, introduced (closed) into the naso-lachrymal duct, after which the blades are screwed apart and the canal widened.

Dilator, Bowman's canaliculus. As is shown in the accompanying figure, the (closed) terminal of this instrument is intended to be in-



Bowman's Canaliculus Dilator.
(Lever Action.)

troduced into a narrowed naso-lachrymal canal and the stricture widened by operating the lower screw in the handle.



Bowman's Canaliculus Dilator.
(Forceps Action.)

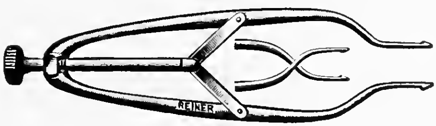
A second form of the Bowman dilator is (see cut) controlled by a forceps handle, provided with a screw.

Dilator, Galezowski's canaliculus. Like the Blitz instrument, the blades of this dilator are introduced closed into the lachrymal passage; the canal is then forcibly widened by separating the handles. See the figure.

Galezowski's Canaliculus Dilator.

Dilator iridis. See **Dilatator iridis.**

Dilator, Lachrymal sac, Todd's. This speculum is employed (see figure) for separating the margins of the wound in excision of the lachrymal sac. See **Lachrymal diseases.**



Todd's Lachrymal Sac Dilator.

Dilator, Lang's canaliculus. This is a valuable little instrument for the dilation of the lachrymal puncta and canaliculi, either for the treatment of stenosis of these passages or as a preliminary to the introduction of other instruments into the canaliculus, sac or nasal duct. See the figure.

Lang's Canaliculus Dilator.

Dilators, Nettleship's canaliculus. These instruments are used in the same fashion and for the same purpose as Lang's dilator, which they greatly resemble. See the illustrations.

Nettleship's Canaliculus Dilator.

Nettleship's Long and Short Taper Lachrymal Dilators.

Dilator, Ziegler's lachrymal. This effective instrument is intended to dilate forcibly and cure by a few applications stenoses of the naso-lachrymal canal. See **Dacryocystitis**; as well as **Lachrymal apparatus, Diseases of the.**

Ziegler's Lachrymal Double-Ended Dilator.

Dill. ANETHUM GRAVEOLENS. The ancients believed that dill, if eaten to excess, would produce diseases of the eyes.—(T. H. S.)

Dilutions. In homeopathic parlance, progressive divisions of the tincture by ten or one hundred. Into a new, clean vial of four or more drams capacity place 1 c.c. of tincture, add 9 c.c. of alcohol, cork with a flawless, well-washed cork, and give for each dilution at least ten forcible shakes upon a pad, or one's knee—"succussion" (q. v.)—then decant and mark the mixture 2x; it is the second decimal dilution, attenuation or "potency" (q. v.). In the centesimal scale 99 parts of alcohol are added to one of tincture or of the preceding dilution.

The drug strength of homeopathic tinctures (*Homeopathic Pharmacopeia of the United States,* Boston) is 1/10, referred to the dry crude drug; when possible the fresh plant is used, but allowance is made for its moisture. The 3x is made by adding 9 c.c. of alcohol to 1 c.c. of the 2x and succussing as above. See **Homeopathy in ophthalmology.**—(J. L. M.)

Dimethylbenzol. This is a class of anilin derivatives that includes toluol and whose ingestion is said to produce visual disturbances.

Dimethyl sulphate. $SO_2(OCH_3)_2$. The toxic properties of dimethyl sulphate, an oily fluid used in manufacturing methyl preparations, were carefully investigated in 1900 by Weber. Erdmann (*Archiv f. Augenheilk.,* p. 178, 1908) now reports another case of injury to the eyes of a chemist from vapors of dimethyl sulphate. In the evening after working in a closed room for several hours, with the dimethyl salt, the patient felt a burning in his eyes which soon increased to intolerable pain, accompanied by lachrymation and photophobia. Both lids were swollen, the ocular conjunctiva was chemotic, and there was profuse watery secretion. Both corneæ showed under the loup a fine, diffuse opacity which consisted of irregularities of the epithelium and spots pervading the whole thickness of the parenchyma. On the following day these lesions had increased in density. They partially cleared up, from the third day, so that after two weeks the patient

could be dismissed with vision almost 5/v. The eyes remained without irritation, but at an examination three weeks later the central, fine, dotted opacity of the cornea remained, as well as at the last examination, seven months later.

That he might study the finer anatomic changes, especially in the cornea, the author made a number of experiments on rabbits and guinea-pigs. Two methods were employed. In the first the animals were exposed to vapors of dimethyl sulphate under a glass globe, with one eye closed by lid sutures and plaster. In the second experiment an eye-cup, which contained cotton soaked with from twenty to twenty-five drops of dimethyl sulphate, was firmly attached to one eye of the animal and winking prevented by a small clasp. After being exposed to the vapors for a certain time, the eyes were examined anatomically. From these observations Erdmann concludes that dimethyl sulphate causes violent inflammatory symptoms in the eye of man and animals. These reach their fullest intensity within twenty-nine hours and present vesicular elevation of the epithelium and parenchymatous opacity of the cornea. The opacity of the cornea consists in an edema of the parenchyma in consequence of a lesion of the endothelium, leading to hydropic degeneration and detachment of the endothelial cells. The vesicular detachment of the epithelium is produced by a transudation between the ground substance and the basal cells, which are shrunken and loosened by the vapors. The imbibition opacity of the cornea subsides with the regeneration of the endothelium, but a fine, dotted parenchymatous opacity remains—due to slight inflammatory changes in the parenchyma. On account of the severe and obstinate inflammatory symptoms and the visual impairment resulting from the residual corneal opacity the greatest care of the eyes is necessary in working with dimethyl salts.

In the case of Adams and Cridland (*Ophthalmoscope*, Vol. 8, p. 717, 1911), after exposure to fumes of dimethyl sulphate there were injection and edema of the ocular conjunctiva, with numerous fine opacities deep in the cornea. Smell and taste were also lost for a short time. Subsequently there was slight contraction of the fields with possible pallor of the disk. Complete recovery finally ensued.

Dinic. Dinical. Pertaining to or useful in the relief of vertigo.

Dinitrobenzol. As de Schweinitz (*Toxic Amblyopias*, p. 127) remarks, this agent results from the action of nitric acid on benzol at a high temperature, and is used in making explosives, such as "roburite" and "sicherheit." Attention was first called to the effect of these substances on the visual functions by Nieden (*Centralbl. f. prakt. Augenheilk.*, 1888, Vol. 12, p. 194), who found defective vision in

one person among twenty-five, who suffered from the toxic influence of the chemical. Ross (*Medical Chronicle,* 1889, Vol. 10, p. 89) mentions the case of a miner who used roburite, and who "felt blind" when fixing his eyes in a certain position, *i. e.,* on a mirror placed above their level. The imperfect vision was probably due to the nystagmus from which he suffered, and not to the nitro-benzol. White (*The Practitioner,* 1889, Vol. 43, p. 14; and *Provincial Med. Journ.,* 1892, Vol. 2, p. 462) has made a thorough study of nitrobenzol poisoning, and refers to the eye affections as comparatively rare, six cases only having come under his observation in a wide experience. Litten (*Centralbl. f. prakt. Augenheilk.,* 1891, Vol. 15, p. 118) reports a typical case of amblyopia from this cause, and Simeon Snell (*Brit. Med. Journ.,* 1894, Vol. 2, p. 449) contributes a thorough paper on the ocular lesions in dinitrobenzol-amblyopia, and describes five cases, in addition to many examinations among the workers. F. A. Pockley (*Australas. Med. Gaz.,* Sydney, 1894, Vol. 13, p. 340) has also recorded a case in Australia. See **Toxic amblyopia.**

Dinus. An obsolete, or little used, term for vertigo or dizziness.

Diodorus. A celebrated blind philosopher of ancient Rome, preceptor to Cicero. He was a man of immense learning and industry. There was another blind philosopher of about the same period, known as Diodorus the Stoic.—(T. H. S.)

Diogenal. A trade (Merck) name given to a derivative of veronal, and used like that remedy as a sedative and hypnotic in doses of one-half to two grams. It is prepared in powder and in half-gram tablets. A full account of the action of diogenal is furnished by Mörchen (*Münch. med. Wochenschr.,* No. 48, 1913) in which he recommends the remedy as a substitute in certain cases for adalin, veronal and bromural.

Diogenes of Apollonia.* (*Circa* 460 B. C.) A Greek philosopher of the first (the Ionic) school of philosophy. He taught, like his predecessor, Anaximines, that air is the source of all things, the one primary element. In accordance with this fundamental doctrine, he ascribed immense importance to the various winds in the etiology both of disease and of health.

Ophthalmologically Diogenes possesses considerable interest, because he was one of the first in all history to attempt an explanation of the visual act. His explication is just a bit involved—or at least we may say that it seems to be so, for we know of the matter only through

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* Not to be confounded either with Diogenes, the famous Cynic (about 412 B. C.), or with Diogenes Lærtius, the biographer of the Greek philosophers (about 200 A. D.).

certain fragments transmitted by Theophrastus—but, as nearly as we can tell at the present time, his theory of vision was this: Certain passages lead down into the eye a kind of air which is really but a small portion of the soul itself. This bit of soul, being in the eye, meets in the pupil an image of the object looked at, and so perceives it.

It will have been observed that Diogenes makes no attempt to explain how the image arrives in the pupil, neither does he understand at all that the brain has aught to do with the matter. In fact, the brain was supposed even by the great Hippocrates (who lived somewhat later) to be merely an enormous gland.

Diogenes taught also that the great variations in visual acuity presented by the eyes of different persons, were due (1) to differences in the fineness of the soul itself, and (2) to differences in the fineness of the passages by which the soul was enabled to penetrate the eye. He also thought that the color of eyes had much to do with visual acuity, at least under special circumstances. Thus, dark eyes (according to him) see better by day; light-colored eyes, on the contrary, by night.—(T. H. S.)

Diomedes. Son of the impetuous Tydeus, and, at the siege of Troy, leader of the tribes which belonged to the government of the Amythonidæ. According to Pausanias (*"Description of Greece,"* II, 24) he erected in Argos a temple to the sharp-sighted Minerva, out of gratitude for the aid which that goddess had rendered him, when, before Troy, he had been attacked by some affection of the eyes.—(T. H. S.)

Dionia. The latinized form of dionin.

Dionin. Dionia ethyl-morphine hydrochloride. Codethyline hydrochloride. An important and most useful therapeutic agent, first introduced by Merck under its trade name. It is made by the action of ethyl iodide on morphia. It is a fine, white, odorless, crystalline powder with a slightly bitter taste, soluble in seven parts of water and four of alcohol. It melts and decomposes at 125° C. (257° F.). It is incompatible with alkalies and their carbonates.

Dionin, for which we are clinically indebted to Wolfberg and Darier, is one of the most valuable analgesic remedies we possess for the relief and curative treatment of corneal ulcer, acute glaucoma, iritis, scleritis and other inflammatory disease of the uveal tract. The relief given to the pain in most cases is prompt and complete. It may be used hypodermically (as an adjunct to atropia) but is commonly employed as a collyrium in 5 or 10 per cent. solution. The greater the edema of the conjunctiva the more decided is the analgesic action of the agent. The Editor has not seen any ill-effects from its local

use, even when the conjunctivæ and lids are much swollen, nor when the saturated solution or the powdered drug has been employed at intervals for a long period. Indeed, there is every reason to regard this drug as among the best additions to the therapeutic list.

It is good policy for the surgeon to make the first application of dionin himself that he may take note of its effect and thus gauge the strength of subsequent doses, and that he may explain to the patient that the swelling of the conjunctiva and eyelids is a *sine qua non* of the treatment and that these apparently alarming symptoms will shortly subside with benefit, and not harm, to the eye. The Editor has known patients to seek the service of "another oculist" because of neglect of this precaution.

It must be remembered, in the administration of dionin, that one should begin with the smallest dose that will produce a decided swelling of the conjunctiva and not increase it until it begins to fail (as it commonly does) to produce the desired chemosis of the conjunctiva or to relieve the pain. The Editor has not found it of much value in the clearing of true scars, although keratitic infiltrates often disappear, especially when used in conjunction with massage with mercurial ointments.

Undoubtedly dionin solutions—5 per cent. is a good average adjuvant—increase the analgesic and other effects of several important alkaloids used in ophthalmic practice. This is notably true of eserin and atropin, and is a most valuable advantage.

Dionin has been shown to have a favorable influence on the healing process after operations and injuries. It also assists the action of atropine and of antiseptic compresses in this way, so much so that in many cases it seems to be indispensable. The action of the preparation in corneal ulcer, opacities and infiltration (including their after-treatment) has resulted in an acuity of vision seldom attained without the use of dionin. The action of the remedy may be regarded as sufficient as long as its use is followed by chemosis, redness, and by burning sensations for 1 to 2 minutes afterwards. Under these circumstances it may be instilled once a day; as soon as they decline it is used every second day, or twice a week. The mode of administration must be selected to suit the condition of the eye at the time. It may be dusted in with a brush in the form of a powder, or it may be applied mixed with yellow mercurial ointment.

von Arlt and Foerster both recommend, as one effective means of breaking down adhesions between the iris and the capsule of the lens resulting from iritis, to place some powdered atropine in the sac and then follow it, a few minutes later, by a little powdered dionin.

A combination of dionin with pyoktanin has been found useful by Wicherkiewicz in various suppurative conditions of the eye. A 1 to 500 solution of pyoktanin is first instilled, and dionin is then dropped in. The latter is used in increasing strength from time to time because of the well-known tolerance that is soon established.

The ointment form of exhibiting dionin is popular with several surgeons who prefer it in the proportion of 0.25 to 0.75 grm. to 15 grm. of petrolatum—4 to 12 grs. to the half ounce.

J. M. Woodson has had excellent results in the treatment of corneal opacities from the local use of dionin in the form of powder. He has noticed that the improvement continues as long as the drug produces irritation of the cornea and conjunctiva.

H. V. Würdemann uses it in powder form applied to the conjunctival cul-de-sac for the absorption of intraocular exudates. (Wood's *System of Ophthalmic Therapeutics*, p. 456.)

Franz Toczyski (*Zeitschr. für Augenheilk.*, p. 32, July, 1912) reports in detail his experiments on twelve eyes with normal tension, tested with the Schiőtz tonometer before and after the application of dionin, from which he reached the following conclusions: Dionin causes miosis of longer or shorter duration, which in the majority of cases passes into mydriasis. The miosis fluctuates during the chemosis of the conjunctiva and lids, while the mydriasis is limited. The duration of mydriasis has no intimate relation with that of miosis. The intraocular tension rises after the application of dionin and, after reaching a certain maximum, declines to or below the normal state. The fluctuations of tension have only this relation to the changes of the width of the pupil, that the tension is augmented during miosis. During mydriasis it increases, is normal or is diminished.

Darier (*Therapeutic Gazette*, Feb., 1904) still claims that it not only possesses a profound analgesic power, but that it also has a favorable action upon the morbid process itself, facilitating the dilatation of the pupil (when it is slow under the action of atropine), assisting the resorption of pupillary exudates, and lastly diminishing tension in cases of glaucoma. His discovery of these reputed properties of the drug was purely accidental. He had been treating an obstinate iritis for several days without avail, when it occurred to him to try the effect of dionin. About one-fourth of a grain of the powder was placed in the conjunctival sac, producing at first much smarting, followed soon after by a sense of numbness and marked serous infiltration under the conjunctiva; the eyelids, too, became much swollen. One hour later the pupil was fully dilated and the pain much relieved. Two days later the patient returned, reporting that she had been

entirely free from pain during that time, and the eye was almost free of congestion. This experience was shortly repeated in several other cases, and Darier soon after made an enthusiastic report on the use of the drug.

Dean (*Iowa Med. Journal,* May 15, 1907) used this drug in 5 per cent. aqueous solution, and has found that, while the well-marked hyperemia and edema are not produced after instilling it for ten days, the improvement in the pathologic condition goes on just the same. In some diseases, especially old cases of keratitis parenchymatosa, no beneficial change has been noticed until it had been used daily for three weeks.

Eight cases of trachoma with cicatricial lids from which granulations had been removed, with opacities of the cornea and pannus in every case, and which had received ordinary treatment for several months, were all much better at the end of eight weeks' use of dionin. Great improvement was noted in all but one patient at the end of four weeks. Thirty other cases of trachoma were greatly benefited, but these patients were previously untreated. In interstitial keratitis and iritis it is very useful, particularly in the latter following cataract operation and injuries. In iritis it does not always have an analgesic power. In ulcer of the cornea its best influence is exerted during and after healing, its action being wonderful in aiding the absorption of recent cicatrices. It is excellent for clearing up recent opacities of the cornea, but does not improve old opacities. In recurrent scleritis the author has diminished the duration of the attacks by at least one-third.

Sylla, of Bremen, has strongly recommended a *new form of dionin,* an ethylmorphin hydroiodicum, instead of the older form, an ethylmorphin hydrochloricum. He stated that the change of the acid radical from chlorine to iodin produced a salt which was much less painful in action, and more effective in that it was more soluble.

von Arlt has examined these claims. He concedes that the ioddionin is almost painless, but his experiments show that it is much less soluble than the chlor-dionin.

He has made experiments with many drugs to ascertain the influences that control their solubility, particularly when the solid drug is applied direct to the conjunctiva. He drags the lower lid away from the globe and applies the powder to the lid, keeping it from contact with the globe. He finds that three factors influence the solubilities: (1) the quantity of tears; (2) the amount of sodium chlorid in the tears; and (3) the amount of albumin. The first content is the more important. In laboratory experiments he finds that a 1.5 per

cent. solution of common salt will take up dionin more rapidly than a 0.5 per cent. solution.

Comparing the two salts of dionin, he found that a 1.5 per cent. solution of common salt took up a given quantity of chlor-dionin in nine minutes, whilst the like quantity of iod-dionin was still undissolved in an hour, notwithstanding constant stirring.

Arlt proceeds to discuss the virtues of the old dionin and gives the following case:—

A woman of 57 years, whose corneæ were grossly scarred from the effects of trachoma, and operations intended to relieve the condition, had only vision of 5/120. He applied 10 per cent. dionin once a week for five weeks. Each time there was an enormous reaction lasting 24 hours. At the end of the period the vision reached 5/30, later 5/20 and 5/18.

(Abstracted from the *Wochenschr. f. Ther. u. Hygiene des Auges,* May, 1909, by Bishop Harman in the *Ophthalmic Review* for Oct., 1909.)

Some observers claim a *deep action* for dionin, *i. e.,* that it has therapeutic value in the treatment of diseases of the posterior intraocular structures. In addition to those already mentioned von Arlt (*Wochenschr. f. Ther. und Hygiene des Auges,* Mar. 19, 1908) used it in a case of myopia of 5 D., V = 5/viii, an oval hemorrhage near the macula with a corresponding scotoma. Color-sense showed diminution of one-half for green alone. No change having occurred in eight days, 0.005 gm. of dionin was placed in the conjunctival sac. In three minutes there was marked lymphatic engorgement which had reached its height in ten minutes. Five minutes later the patient remarked that the spot before the eye was smaller and fainter. V. = 5/vi pt. Next day V. = 5/iv pt. The hemorrhage, the difference in color-sense and the scotoma had entirely disappeared. About one month later the patient returned with episcleritis but the visual functions were normal.

The author has no scruples in crediting the dionin with the result, as he states that he had followed the case before, during and after the employment of a single therapeutic measure.

As an analgesic Adam (*Amer. Jour. Ophth.,* Vol. 27, p. 182, 1910) finds that dionin fails in about 25 per cent. of the cases; and where, at first, it relieves pain, it often speedily loses this power. It frequently causes severe burning, which can be prevented by a previous instillation of novocain. When effective it produces chemosis and therefore cannot be freely used on out-patients. He does not find its resorbent efficiency greater than that of older measures for this purpose.

Orth (*Woch. f. Therap. u. Hyg. d. Auges,* July 27, 1911) reports a remarkable cure of chronic iritis when dionin was used. He applied it in powder twice a week, and no loss of action was observed after two months. Dionin is generally used too frequently; not only leading to loss of its action, but also failing to get the full benefit from even the first applications. Kaz (*Woch. f. Therap. u. Hgy. d. Auges,* Vol. 15, p. 301, 1911) also reports benefit from dionin in severe inflammatory conditions, especially relief of pain. He combines with it dressings moistened with sublimate solution, believing these produce a similar effect. Posey (*Ophth. Record,* Vol. 21, p. 211, 1911), although skeptical as to the value of dionin for clearing up opacities, thinks that it helps to secure the maximum action of atropin in iritis.

Marquez (*Arch. de Oftal. Hisp.—Amer.,* Vol. 10, p. 142, 1910) finds that codein hydrochlorate produces local anesthesia, and in several respects resembles dionin in its action. Bonsignorio (*La Clin. Opht.,* Vol. 16, p. 276, 1910) recommends codein hydrobromate as a satisfactory *substitute for dionin.* It proved effective for the relief of neuralgias, and serves as a revulsive and lymphagogue. It is used in a solution of 1 to 5 per cent., producing much the same redness, burning, stinging and chemosis as dionin. These symptoms disappear completely in an hour or two after the use of the stronger solution.

Diophthalme. (F.) A bandage for both eyes; also, a binocular glass.

Diophthalmus. Diprosopus. A bandage for both eyes.

Diophyrs. In ornithology, having double eyebrows, or with the eyes situated between two black stripes.

Diops. (L.) Having two eyes.

Diopsimeter. An instrument devised by R. Houdin for measuring the extent of the visual field. A perimeter.

Diopter. Dioptre. Dioptry. Sometimes spoken of as a Dioptric. The unit of refraction of lenses, being the refractive power of a lens of the focal distances of 1 metre. See **Dioptry.** 1. A leveling instrument consisting of a plank turning through a semicircle on a stand, and provided with sights at the two ends and a water-level. 2. An ancient form of theodolite. 3. The alidade or index arm of a graduated circle. 4. An instrument used in craniometry for obtaining projections of the scull. 5. See **Dioptry** (Diopter).

Diopter, Prism. Chas. F. Prentice (*Archives of Ophthal.,* 3, 1890) proposed that the measure of a prism be the tangent of the deviation for a radius of one metre. His unit is a prism which at this distance produces an apparent displacement of one centimetre; and he calls it the "prism dioptre."

Dioptometer. An instrument for the measurement of ametropia. An

accommodometer; a punctumeter or optometer. See p. 55, Vol. I of this *Encyclopedia*.

Dioptometry. DIOPTROMETRY. The science and art of measuring the accommodation and the refraction.

Dioptoscopy. A method of determining the refraction of the eye by means of the ophthalmoscope.

Dioptra. (L.) DIOPTRION. An ancient optical instrument for measuring heights and angles.

Dioptral. Pertaining to a dioptry; expressed in dioptrics. In *optics,* applied to the refractive power of ophthalmic lenses numbered according to the metric system, and in which the unit has a focal length of one metre. Thus, a one-dioptry lens is specifically a member of the dioptral system, whereas a lens of equivalent focal length broadly speaking is a member of a dioptric system: telescope; microscope.

Dioptral formulæ. Algebraic equations in which the dioptral values of lenses or prisms are the principal factors.

Dioptric. 1. Affording a medium for sight; assisting vision in the view of objects. 2. Pertaining to dioptrics, or the science of refracted light.

Dioptrically. By reflection.

Dioptric apparatus. The simplest form of dioptric apparatus consists of two media of different refractive indices separated by a spherical surface. The optical properties of such an apparatus depend on (1) the curvature of the surface, and (2) the refractive powers of the media. Such a simple optical system is shown in the figure.

The line P-R represents a curved surface separating media of different refractive power, the less being on the left. The line O-A, falling perpendicular to the surface at 3, passes through the centre (6) of the sphere with whose surface we are dealing. This line, O-A, is the optic axis. All lines which cut the surface normally, such as O-A, C-Y, and U-I, undergo no refraction. They continue in straight lines and cross at 6, which is the nodal point. All other rays passing from a medium of less to one of greater density are refracted. All lines lying in the first medium and parallel to the optic axis will be bent so as to meet at M, which is the principal posterior (or second) focus. On the optic axis, in the first medium, is an important point, B. Rays of light passing from B, such as B-I-T, are so refracted that they become parallel to the optic axis. B is called the principal anterior (or first) focus. The point where the optic axis cuts the surface is called the principal point. The above-mentioned points—posterior and anterior foci, the nodal point, and the principal point—are called the cardinal points of an optical system. (Cardinal points

are certain fixed points for a given system of refracting surfaces. A knowledge of these enables optical mathematicians to construct and calculate the situation and size of the images of given objects.)—(J. M. B.)

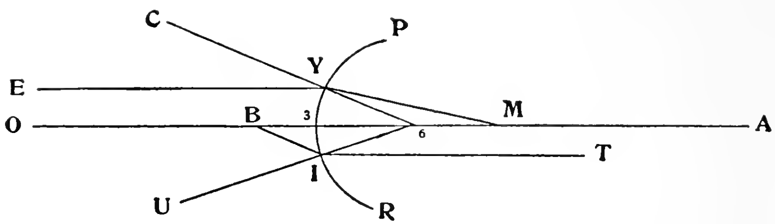

Diagram of a Simple Optical System.

Dioptric formulæ. Algebraic equations which incorporate the dimensions of refractive media.

Dioptric formulæ for combined cylindrical lenses. See **Ophthalmic lenses and prisms.**

Dioptric light. Light in which the beam is produced by refraction.

Dioptric medium. This term is applied to any substance that will transmit light, that is through any transparent medium.

Dioptrics. That branch of optics which treats of the refraction of light passing through different media, as air, water, or glass, and especially through lenses. The term is not now much used by scientific writers, the phenomena to which it refers being, as a rule, treated under the general head of **Refraction.**

A complete understanding of this subject is necessary for the study of physiological optics (which will elsewhere be fully considered) to which it may be regarded as, in part, an introduction.

REFLECTION BY PLANE, CONCAVE AND CONVEX SURFACES.

In a homogenous medium, light waves are transmitted along straight lines known as luminous rays. Light emanating from a point travels equally in all directions, provided the medium remains unchanged. Consequently any consideration of actual changes in the direction of light rays must involve three dimensions. But for ordinary, practical purposes we need consider the changes that occur only in two dimensions.

Light rays emanating from a point on an object are again brought to a point by reflection or refraction, thus forming an image, and the

points thus located are called conjugate points. An image formed in this manner and capable of being thrown upon a screen is called *real*, whereas an image formed by the prolongation of divergent rays and capable of being seen only because the eye comes within the path of these rays, is called *virtual*.

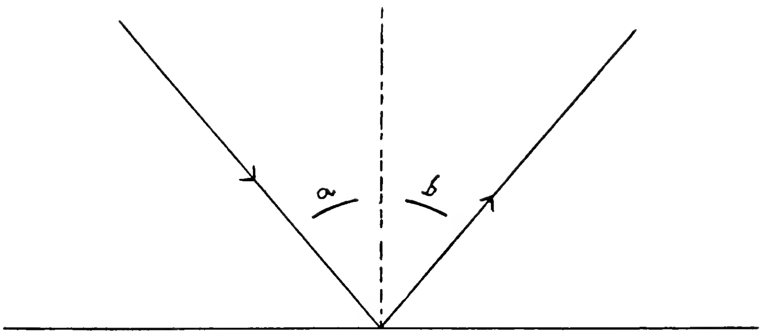

Fig. 1. Reflection from a Plane Surface.
Angle $a =$ angle b.

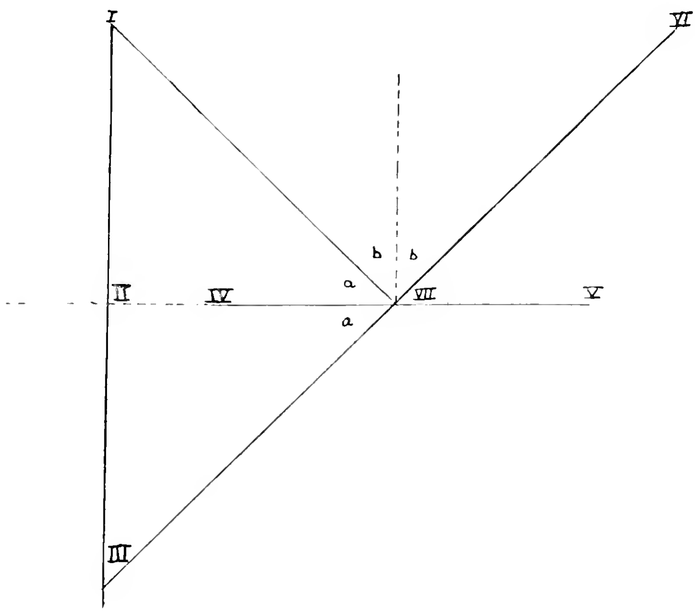

Fig. 2. Reflection from a Plane Surface.
Size of Image.

Light rays striking a surface are partially reflected and partially absorbed. The higher the polish of the surface, the greater are the number of rays reflected, and vice versa. Thus the reflection from a plane mirrored surface is so great, *i. e.*, so few rays are absorbed, that

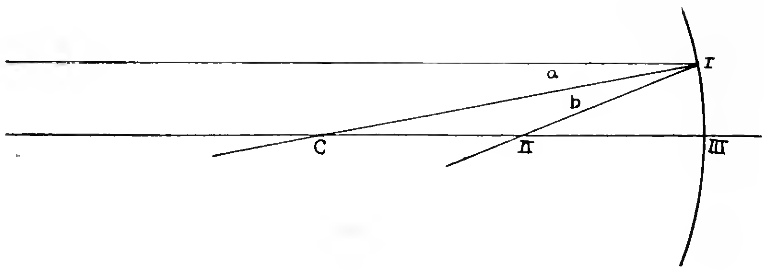

Fig. 3. Reflection from a Spherical Surface.
The main focus is half way between the surface and the center.

the surface is scarcely visible. This reflection follows unyielding laws which were among the earliest known laws of optics. *The angle of reflection is equal to the angle of incidence and lies in the same plane.* (Fig. 1.)

The image formed by reflection from a plane surface is virtual,

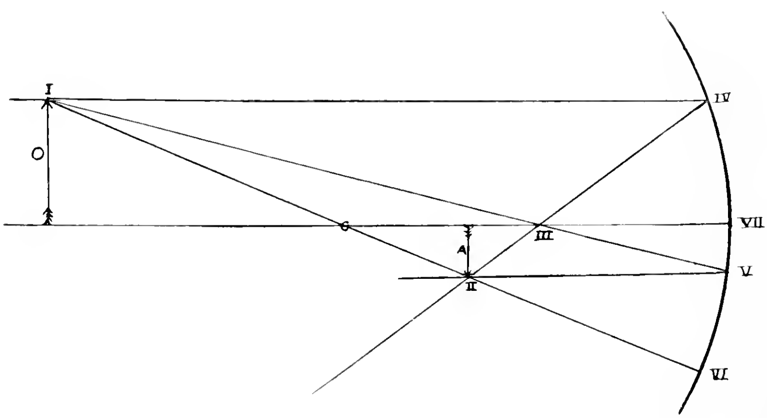

Fig. 4. Reflection from a Spherical Surface.
Formation of Image.

erect, and equal in size to the object. (Fig. 2.) If I be a point on an object and IV-V a plane mirror, the image can be constructed by dropping a perpendicular from I to the mirror. Continue this an equal distance beyond the mirror to III. Thus the angle I-VII-VI

is equal to the angle I-VII-III, the angle a equals the angle a and the angle b equals the angle b. Therefore III is a corresponding point to VI and the image is the same. The course of all rays is reversible; hence the ray I-VII-VI must travel the same path as a ray emanating from VI and reflected at VII, but in a reverse direction. Consequently, the principal focus of a plane mirror is at infinity, for parallel rays, striking its surface, remain parallel after reflection.

The axis of a concave spherical mirror is the line connecting the center of the mirror with its center of curvature or the apex. The principal focus of such a mirror, or the point to which all incident rays parallel to the axis are reflected, lies half way between the apex and the center. In order that the image remain true, the aperture of

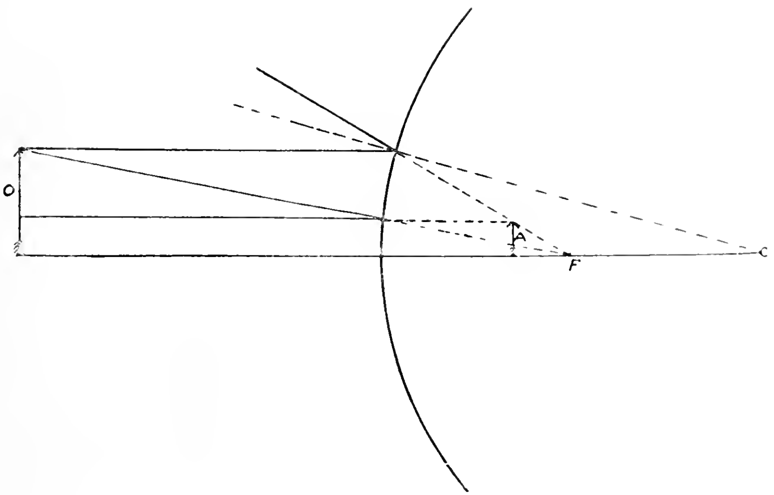

Fig. 5. Reflection from a Spherical Surface.
Formation of image by a convex mirror.

the mirror or its angular measurement, must remain small, *i. e.*, not exceeding 9°. A glance at Figure 3 will show the proof of the location of the principal focus. A ray, parallel to the axis, strikes the mirror at I and as the angle of incidence is equal to the angle of reflection, it is so reflected that it crosses the axis at II. Therefore the angle a must equal the angle b. As the aperture of the mirror is very small, the radius CI is great and consequently the angle b is very small. Thus we may assume that CII + (I-II) = CI, or the radius. As the incident ray is parallel to the axis, the angle I-C-II equals the angle b and therefore CII = I-II = II-III, or one-half the radius. It

follows that a ray passing through the center is perpendicular to the surface and is reflected upon itself.

Bearing these laws in mind, the construction of the image formed by a concave spherical mirror is very simple. To trace the course of three rays is sufficient. (Fig. 4.) The ray IV, parallel to the axis, is reflected through the principal focus along the line IV-III-II. The ray, I-III-V, through the principal focus is reflected parallel to the axis along the line V-II. The ray, I-C-VI, through the center of curvature, is reflected upon itself. The intersection of these reflected rays at the point II, form an inverted, real, and diminished image, provided the object be located beyond the center. If the object be located between the center and the principal focus, the image will be real, inverted, and enlarged, for the course of the rays just demonstrated is reversible. The object, when placed between the principal focus and the mirror itself, forms an image that is virtual, erect, and enlarged and located behind the mirror.

The relative sizes of object and image are easily computed. As the aperture of the mirror must be small, the length VII-V may be considered as a straight line and hence is equal to the size of the image, A.(1.). The angles VII-III-V and I-III-C are equal, hence $O:A = l_1:F_1$. As $F_1 = \frac{R}{2}$, the size of the image depends directly upon the size of the object and the radius of curvature of the mirror and indirectly upon the distance of the object from the anterior focus.

In all succeeding formulæ, the following nomenclature will be used: O—Object: A—Image: R_1—Radius of first surface: R_2—Radius of second surface: F_1—Anterior focal distance: F_2—Posterior focal distance: f_1—Distance of object from surface: f_2—Distance of image from surface: l_1—Distance of object from anterior focus: l_2—Distance of image from posterior focus: For mirrors and lenses with the same medium on both sides, F_1 — $F_2 = F$.

Convex spherical mirrors answer the same laws as do concave mirrors. The construction of the image is similar except that it is located behind the mirror, is virtual, erect, and diminished. The actual reflected rays are divergent, hence their prolongation forms the mental picture. Here, too, the focus is an equal distance between the surface and the center. (Fig. 5.)

The practical application of these laws and their geometrical proofs scarcely need mention. The kind of mirror can be determined by approaching it until the eye is between the focus and the surface. A convex mirror will give a diminished image, whereas a concave will

yield a magnified image, and the image of a plane mirror will be equal in size to the object. Only the latter two mirrors are used in ophthalmology; the plane mirror for the simple examination of the refracting media where no great amount of light is necessary; and the concave mirror whose reflected rays converge, where more light is required. The convex mirror reflects rays divergently.

REFRACTION.

A polished surface separating two transparent media divides an incident ray into a reflected ray and a refracted ray, all lying in the same plane. A refracted ray is one passing through the surface into the second medium, but bent away from the line of the incident ray. This ray, too, follows a certain definite course, obeying the law of Descartes. The ratio between the sine of the angle of incidence and the sine of the angle of refraction is constant, independent of the angle of incidence, as long as the two media remain the same. Thus we have the equation $\frac{\sin i}{\sin v} = \text{constant} = n$. With air adopted as a unit, we designate n as the index of refraction. Water has an index of 1.333 and glass of the usual sort about 1.5.

If the angle of incidence be not too great, a certain amount of light is reflected and a certain amount refracted. A polished glass surface reflects about 4 per cent. of incident light, while a good metallic surface reflects about 65 per cent. But if rays coming at a greater angle of incidence meet a medium of different density, the light is totally reflected. The angle determining this is called the critical angle and if this be exceeded by the angle of incidence, we have the phenomenon of total reflection. The critical angle is also known as the angle of incidence corresponding to the angle of refraction of 90°. The sine of the angle of refraction = 1 and $\sin i/\sin r' = n' = \sin i/1' = \sin i' = n$. If the two media be air and water, then $n = \frac{3}{4}$ and $\sin i' = 0.75$ and the critical angle = 49°. The most common form of total reflection used is the rectangular prism with three polished faces. (Fig. 6.) This is employed freely, both theoretically and practically in a majority of optic problems.

Rays passing through a prism seem deflected toward the apex of the prism and the angle thus formed is called the deviation. *The deviation produced by a weak glass prism is equal to one-half its angle.* The proof for this had best be given in Tscherning's own words: "If i

equals the angle of incidence, i_1 the angle formed by the emergent ray with the normal, A the angle of the prism and d the deviation, we have $d = i + i_1 - A$, for $d = i - r + i_1 - r_1$ and $A = 180° - x =$

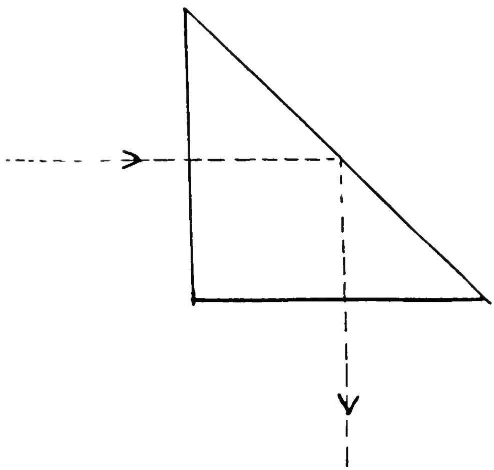

Fig. 6. Total Reflection by a Prism.

$r + r_1$; therefore $d = i + i_1 - A$. The deviation is least when $i = i_1$, the course of the rays is then symmetrical and we have $A = 2r$ and $d = 2i - 2r = 2i - A$. In the formula, $\sin i = n \sin r$, we can replace the sines by the arcs if the latter are small; therefore $i = nr$

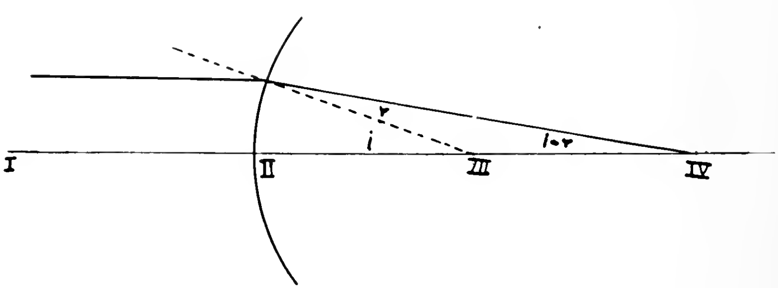

Fig. 7. Refraction by a Spherical Surface.
Parallel rays reunite at the posterior focus.

and $d = 2nr - A$, or $d = (n\text{-}1)\ A$. If the prism is glass, we have n equaling approximately 3/2, n-1 equaling one-half."

In considering refraction by spherical surfaces, we must first speak of two media whose line of contact forms a spherical surface, then

of infinitely thin lenses, and finally of commercial lenses. The consideration of the first two subjects must necessarily be more or less theoretical, whereas the latter is eminently practical.

Refraction by a spherical surface. Rays coming parallel to the axis are so refracted that they reunite at the posterior focus, the distance of which from the center is known as F_2. According to our previous formulæ (Fig. 7), $\frac{\text{III-IV}}{R} = \frac{\sin r}{\sin (i-r)}$. As the angles are small, the sine equals the angle and $\frac{\text{III-IV}}{R} = \frac{r}{i-r} = \frac{r}{nr-r} = \frac{1}{n-1}$. Consequently $\text{III-IV} = \frac{R}{n-1}$ and II-V or $F_2 = \frac{R}{n-1} + R$ or $\frac{nR}{n-1}$. This is the posterior focal distance. The anterior focal distance or F_1 may be expressed by

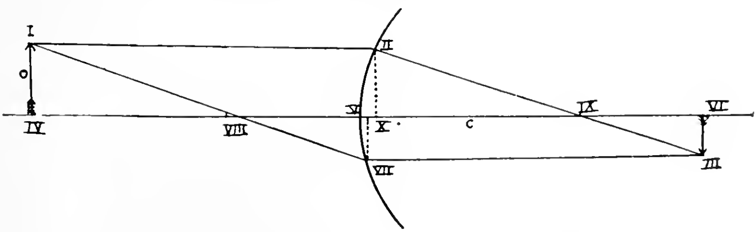

Fig. 8. Refraction by a Spherical Surface. Formation of inverted diminished image.

the formula following similar calculation. Incident rays from the anterior focus are parallel after refraction.

Comparing our formulæ, we can see that $F_2 = F_1 + R = n\,F_1$. Translated, this means that:

1. The difference between the focal distances is equal to R.
2. The ratio between the focal distances is equal to the ratio between the indices of refraction of the corresponding media.
3. The distance of the center from the posterior focus is equal to F_1 and the distance of the center from the anterior focus is equal to F_2.

For $\text{I-II} = \text{IV-III} = F_1.$
$\text{II-IV} = \text{I-III} = F_2.$

Here, as in the case of a reflecting surface, the image may be obtained by three rays. (Fig. 8.) The first ray parallel to the axis is refracted so as to pass through the posterior focus, IX. An axial ray passing through the center is not deviated, IV-VIII-IV. A ray passing through

the anterior focus, VIII, becomes parallel to the axis after refraction, and the intersection of these rays forms the image.

The triangles I-IV-VIII and VIII-V-VII are equal as are the triangles II-IX-X and X-VI-III. Therefore we have the same relations as for reflecting surfaces and $\frac{o}{A} = \frac{l_1}{F_1} = \frac{F_2}{l_2}$. From this we can derive the general formula $l_1 l_2 = F_1 F_2$ and $\frac{F_1}{f_1} = \frac{F_2}{f_2} = 1$. Thus we can see that the image is real and inverted, provided the object be located beyond the anterior focus. If the object is between the focus and the surface, the image is virtual, erect, and enlarged.

Infinitely thin lenses. In considering the optical properties of lenses, we must first deal with infinitely thin lenses and this is necessarily theoretical. Hence, the term lens, when used in this article, refers to an infinitely thin lens. The axis is the straight line that joins the centers of the two surfaces, and the optic center, the point where this axis crosses the lens. Because of the character of the lens, any ray passing through this point is not deviated.

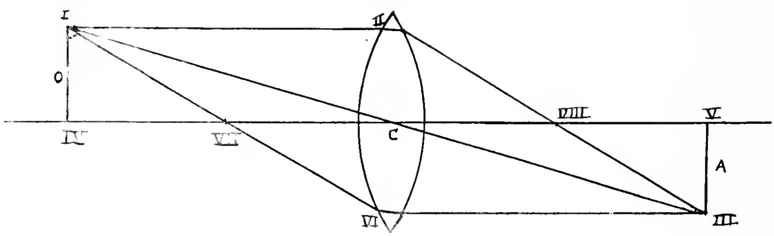

Fig. 9. Refraction by Infinitely Thin Lenses.
Formation of inverted image of equal size.

Biconvex lenses. The anterior focal distance of a biconvex lens is the same as the posterior focal distance and therefore their formulæ remain the same. Incident rays, parallel to the axis, are refracted to the posterior focus, whose distance is expressed by the formula $\frac{nR}{n-l}$.

This point must now be considered as the object of the second surface, but as it is behind the surface, it has a negative value. $\frac{F_1}{f_1} + \frac{F_2}{f_2} = l$ and $f_1 = -\frac{nR_1}{n-l}$ calling R_1 and R_2 the radii of curvature

of the two surfaces. F_1 is equivalent to $\frac{nR_2}{n\text{-}1}$ and F_2 to $\frac{R_2}{n\text{-}1}$. Therefore

$$\frac{\frac{nR_2}{n\text{-}1}}{\frac{-nR_1}{n\text{-}1}} + \frac{\frac{R}{n\text{-}1}}{f_2} = 1 \text{ or } \frac{-R_2}{R_1} + \frac{R_2}{(n\text{-}1)f_2} = 1$$

$$\frac{R_2}{(n\text{-}1)F_2} = 1 + \frac{R_2}{R_1} = \frac{R_1+R_2}{R_1}$$

$$\frac{1}{f_2} = (n\text{-}1)\frac{R_1+R_2}{R_1R_2} = (n\text{-}1)\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$$

which in turn equals $\frac{1}{F}$. (See Fig. 9.)

The construction of an image by such a lens is simple. The incident ray, I-II, parallel to the axis, is refracted through the posterior focus and the ray, I-VII, through the anterior focus, emerges parallel to the axis. The ray I-C, through the optic center, is not deviated. The calculations here are the same as in the case of the mirrors and we find that if the object is beyond the focus, the image is real and inverted. It is enlarged if the distance of the object from the lens is less than double the focal distance and if this be not the case, the image is diminished in size. If the object is between the focus and the lens, the image is virtual, erect, and enlarged.

Concave lenses diverge rays by refraction instead of converging them as do convex lenses. As the surfaces are concave the radii and focal distances must be considered negative, and allowing for the necessary changes in signs, the calculations are identical with those employed for convex lenses. In the case of a concave lens, the image is virtual, erect and smaller.

A meniscus is a lens, one surface of which is concave and the other convex. According to whether the radius of the convexity or concavity is greater, the meniscus is called convergent or divergent.

The refracting power of a lens is expressed in diopters as the inverse of the focal distanee measured in meters. Formerly this power was designated by the radius of curvature of the lens, but that system has been entirely discarded.

Lenses of positive thickness. For the practical calculation of the refracting power of a lens whose thickness is an appreciable quantity, two methods are open to us. The first and one least used is to construct the image formed by the first refracting surface and then regard this as the object for the second refracting surface and so on. The second and commonly employed method is the application of the *theory of Gauss.* This theory presupposes that the lenses are centered upon a common axis and that the apertures are sufficiently small to prevent spherical aberration.

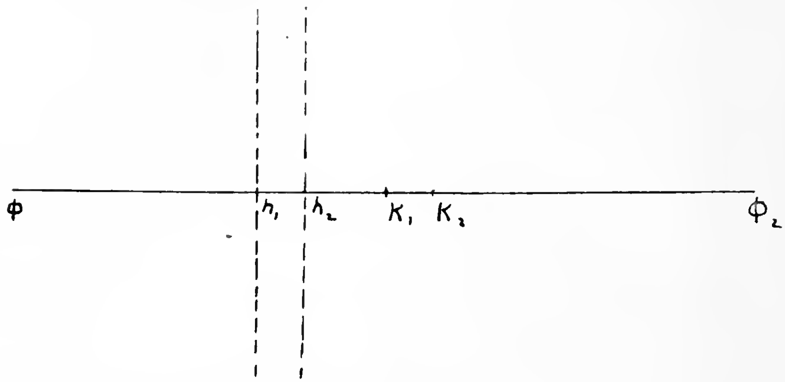

Fig. 10. The Six Cardinal Points of any Optic System according to the Law of Gauss.

According to this theory, every optic system has six cardinal points. (Fig. 10.) Two principal points, h_1 and h_2; two nodal points, K_1 and K_2; one anterior focus, Φ_1; and one posterior focus, Φ_2. The anterior focal distance, F_1, is equal to the distance of the second nodal point from the posterior focus, $K_2 \Phi_2$, and the posterior focal distance, F_2, is equal to the distance of the first nodal point from the anterior focus, $K_1 \Phi_1$. Consequently it follows that the distance between the principal points is equal to the distance between the nodal points.

The ratio between the focal distances is equal to the ratio between the indices of the first and last medium or $n = \frac{F_2}{F_1}$. The two principal planes are parallel planes passing through the two principal points and an image formed in the one plane is equal in size and in position in the second. The two nodal points are related in that a ray passing through one nodal point necessarily passes through the second and emerges parallel to its original direction.

Bearing these axioms in mind, the construction of the image of a point is similar to that employed for infinitely thin lenses. The ray I-II passes through the first principal plane, *aa,* a point II-h_1 distant

from the axis and must therefore pass through the second principal plane at an equal distance from the axis. Hence II-h_1 = III-h_2 and the ray after refraction must pass through the posterior focus Φ_2. The ultimate direction is III-Φ_2-IV.

The ray, I-V, passing through the anterior focus, Φ_1, is so refracted that it emerges parallel to the axis and assumes the direction V-VI-IV.

The ray, I K_1, passes through the first nodal point; therefore it must pass through the second nodal point, K_2, and emerge parallel to its original direction. Calculation gives us the formula $\frac{F_1}{f_1} + \frac{F_2}{f_2} = 1$.

By employing the formula of Newton, it is not difficult to find the cardinal points of any given system of lenses, such as of a terrestrial telescope. But the intricate calculations necessary for such an operation are somewhat out of place here; for their details the reader is referred to some such authority as Tscherning.

The eye may be considered as such a system and its constants may be thus determined. But these vary according to different authorities and the methods of measurement employed. Probably the best known sets of measurements are those of Helmholtz and by Tscherning, which are reproduced herewith. It must not be supposed, though, that these data are rigorously exact, but they suffice for all simple measurements. By the position of a point is meant the distance of that point from the anterior surface of the cornea.

	Tscherning.	Helmholtz.
Index of the aqueous and vitreous.......	1.33	1.3365
Index of the crystalline lens............	1.41	1.4371
Radius of curvature of the cornea.......	8.0 mm.	7.829
Radius of curvature of the lens:		
Anterior surface	10. mm.	10.
Posterior surface	6.0 mm.	6.0
Anterior focal distance of the cornea.....	24. mm.	23.266
Posterior focal distance of the cornea....	32. mm.	31.095
Focal distance of the lens...............	63.4 mm.	50.617
Anterior focal distance of the eye........	17. mm.	15.498
Posterior focal distance of the eye........	22.7 mm.	20.713
Position of the anterior principal point....	1.6 mm.	1.753
Position of the posterior principal point...	1.9 mm.	2.106
Position of the anterior nodal point.......	7.3 mm.	6.968
Position of the posterior nodal point......	7.6 mm.	7.321
Position of the anterior focus of eye......	—15.4 mm.	—13.745
Position of the posterior focus of eye......	24.6 mm.	22.819

—(H. S. G.)